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The Public Lighting Tables of the American Meter Company will be found in the page advertisement of that Company.

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[OFFICIAL NOTICE.]

Twenty-fourth General Meeting, American Gas Light Association.

OFFICE OF THE SECRETARY,
PROVIDENCE, R. I., Sept. 15, 1896.

There will be a general meeting of the American Gas Light Association held in St. Louis, Mo., on October 27, 28 and 29, 1896.

The meeting will be called to order by the President, C. J. R. Humphreys, of Lawrence, Mass., at 9:30 o'clock, A.M., on Tuesday, October 27, in the meeting hall at the Planters' Hotel, the headquarters, which occupies half a block on Fourth street, between Pine and Chestnut.

The Planters' is one of the very finest hotels in the West, and is conveniently reached by the principal street car lines, and is amply large enough to take care of all who attend the convention. The most satisfactory quarters are always obtained by writing in advance to the hotel people, and in doing so a reply should be requested, for which a self-addressed stamped envelope should be enclosed, as misunderstandings may thereby be averted. The Planters' is conducted on both the American and European plans. On the American plan there will be a few rooms at $3.50, plenty of rooms at $4, with bath, $5; or two adjoining, with bath between, $4.50 each, and up. European plan, $2 and $2.50 and up. Rates are the same for corresponding rooms on all floors above the third. The Southern Hotel is a fine house at Broadway, Fourth and Walnut streets, 2½ blocks from the Planters', and is American plan, $3 to $5 a day. The Lindell is a good house on Washington avenue, between 6th and 7th streets, six blocks from the Planters', and is American plan, $2.50 to $4.50 a day.

The change of date from the third Wednesday of October was made positively necessary by an entirely unforseen occurrence. During the first week of that month St. Louis is filled with visitors to the fall festivities, and this year the second week was chosen for the meetings of two very large associations, the Carriage Makers and the Street Railway people; but as the hotels would be unable to take good care of two such large conventions at the same time, the Street Railway convention was changed to the week of the third Wednesday, and as that convention meant about 3,000 persons in attendance, our members could not have been comfortably housed. The President and Secretary therefore went to St. Louis, and after mature consideration in consultation with the local members, it was fully decided that to hold our meeting on Tuesday, Wednesday and Thursday, October 27, 28 and 29, was the best arrangement that could be made.

The meeting hall will be the Ladies' Ordinary, on the parlor floor of the Planters' Hotel; thus the headquarters and hall will be in the same building.

The roll call will be made by means of the door card system. Each member upon entering the hall for the first time will at the door receive a special card upon which he will find his name, address, etc., as it appears on the Secretary's books, and such card should be corrected and given to the doorkeeper. Members in attendance should attend to this very carefully, as these cards are used immediately after the meeting for correcting the annual membership list. Visitors will please hand to the doorkeeper their personal cards.

A blank form of application for membership accompanies this circular. More can be obtained of the Secretary.

Remember, all applications must be in the Secretary's hands by October 17, at the very latest, otherwise they will not be acted upon at this meeting.

The list of papers to be read at the meeting is as follows:

"A Discussion of the Methods Employed in Introducing Gas Stoves," by Charles H. Nettleton, Derby, Conn.

"Some Experiments on Internal Illumination," by Carter H. Page, Jr., Philadelphia, Pa.

"Inclined Retorts up to Date," by Frederick Egner, Norfolk, Va.

"A Modern Retort House," by Wm. A. Miller, Cincinnati, O.

"The Separation of Water Gas Tar," by Alten S. Miller, Long Island City, N. Y.

In addition to the above there will be several topics brought in for discussion by short written introductions.

All questions for the Question Box should be sent in to the Secretary as soon as possible in order that they may be printed in the next circular before the meeting, thereby insuring their discussion.

During the days of the meeting all announcements will be posted on the bulletin board in the meeting room. All members are warned to take notice thereof accordingly.

All members attending the meeting are particularly requested to wear their membership badges in plain sight, thereby greatly aiding the officers and the Local Committee in their work, by affording a ready means of recognition.

In order that the Year Book containing the report of the St. Louis meeting may be published and issued to the members immediately after the meeting, notice is hereby given that if any of the speakers at that meeting desire to correct their remarks in discussions before they are printed, they will be given an opportunity before leaving St. Louis, but *not* after. The stenographer will have typewritten copy of the principal discussions prepared at the headquarters between the sessions of the meetings, and all those who desire to correct their remarks *must* notify the Secretary at the close of the session at which such remarks are made, as all the report will be turned in to the printer immediately after the adjournment of the meeting.

Special rates for transportation have been granted (viz., full fare going and one-third fare returning by the same route) by the several Passenger Associations named and under the conditions noted.

The Central Passenger Committee, covering the following grounds: Bounded on the east by Pittsburgh, Salamanca, Buffalo and Toronto; on the north by the line of and including points on the Grand Trunk Railway from Toronto to Port Huron, thence via Lakes Huron and Michigan to the north line of Cook county, Ills.; on the west by the west line of Cook county and the Illinois and Mississippi rivers, to Cairo, including Burlington, Keokuk, Quincy, Hannibal and St. Louis; and on the south by the Ohio river, including points on either side of that river.

The Southern States Passenger Association, covering the territory south and west of the Virginias and south and east of the Ohio and Mississippi rivers.

The Trunk Line Passenger Committee, covering territory west of New England and east of Niagara Falls, Buffalo and Salamanca, N. Y.; Pittsburgh, Pa.; Bellaire, O.; Wheeling, Parkersburg and Charleston, W. Va.

The New England Passenger Association, covering nearly all of the lines in the New England States.

The Western Passenger Association, from points in Eastern Committee and Trans-Missouri Committee Territories.

The following extracts from the regulations of the railroads are cited for the information of the members. The special rates are granted subject to these regulations:

1. The reduction is conditional on there being an attendance at the meeting of not less than 100 persons holding certificates.

2. Each person to obtain the excursion rate must purchase a first-class ticket (either limited or unlimited) to the place of meeting, for which he will pay regular fare, and upon request the ticket agent will issue a printed certificate of purchase of the standard form. Agents at all important stations are supplied with certificates.

3. If through tickets cannot be procured at the starting point, purchase short-trip ticket to the most convenient point where such through tickets can be obtained, and there purchase through to place of meeting, requesting a certificate from the ticket agent at the point where each purchase is made.

4. Tickets for the return journey will be sold by the ticket agent at the place of meeting at one-third the highest limited fare, only to those holding certificates signed by the ticket agent at point where through ticket to place of meeting was purchased, and countersigned by signature written in ink by the Secretary of the Association, certifying that the holder has been in regular attendance at the meeting.

5. No reduction of fare will be made on the return passage if the going ticket is purchased more than three days before the opening date of the meeting; except that when meetings are held at distant points to which the authorized limit is greater than three days, tickets may be purchased before the meeting in accordance with the limits shown in regular tariffs.

6. Certificates are not transferable, and return tickets secured upon certificates are not transferable. The transfer of any such is liable to prevent the securing of reduced rates for future meetings.

7. The certificate of agent at starting point, duly endorsed by Secretary of Association, must be presented to ticket agent at place of meeting, within three days (Sunday not reckoned except by Southern Passenger Association) after adjournment of meeting. The return ticket will be for the line or lines covered by the going ticket.

8. No refund of fare will be made on account of any person failing to obtain a certificate.

Special.—Those desiring to join the New England party should communicate at once with C. J. R. Humphreys, Lawrence, Mass. Those wishing to join the New York party should communicate with C. E. Sanderson, 32 Pine street, New York city. Be sure to obtain your railroad certificate when buying your ticket for St. Louis. Apply for ticket and certificate at least 30 minutes before train time. Each person must sign his own certificate at time of purchasing ticket for St. Louis. Be sure to have the Secretary endorse your certificate at St. Louis as soon as you get there. Apply for return ticket at least 30 minutes before train time, and have your certificate with you. Any person, ladies included, attending the meeting, is entitled to the reduced rate from the territories named.

Members will please hand their certificates to the Secretary, or his Clerk, upon arrival at place of meeting. If there are one hundred members present, holding certificates, each certificate will then be properly endorsed and handed back to owner before adjournment.

A. B. SLATER, JR., Secretary.

The Belfast (Ireland) Gas Works.

[A paper read by MR. JAMES STELFOX, Engineer and Manager of the Belfast Works, before the Institution of Mechanical Engineers.]

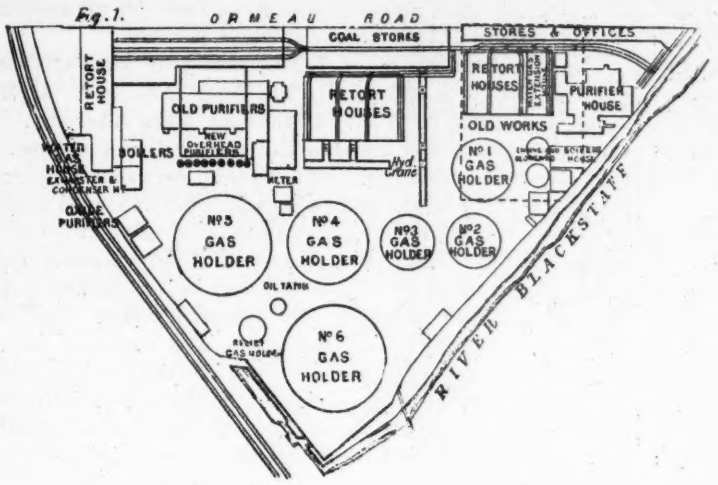
Historical.—The gas industry may be said to date from the early years of the present century, though numerous records prove that private establishments were lighted by means of coal gas at a considerably earlier period. The first public lighting of London by gas was witnessed in 1813 on Westminster Bridge; and within the next few years a rapid extension of the plan took place, not only in the metropolis, but also throughout the country. In Belfast, notwithstanding its remoteness at that period as regards time and convenience of transit from those manufacturing centers which seem chiefly to have excited the enterprise of the pioneers in gas engineering, the subject received attention as far back as 1817, when the original projectors of the gas works appear to have been represented by Mr. E. Spear, with Messrs. Barlow Brothers as engineers and architects for the undertaking. About 1821 a start was made on a little plot of land on the Ormeau road, shown dotted on Fig. 1, the site being now occupied by a portion of the present offices and by the retort house, etc., of the old section of the works. The contract for laying the necessary pipes and services was given to Mr. Charles Burt Robinson, of London, whose name was afterwards well known in connection with the gas undertakings of Leicester, Coventry and Leamington, and with the gas industry generally. The works were first brought into use in the autumn of 1823, and in the Belfast *News Letter* of September 2 of that year appeared a long and interesting account of the new undertaking.

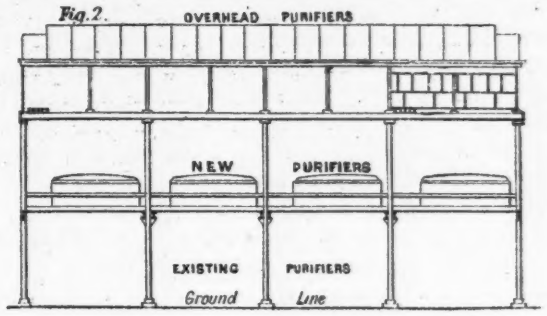
The works stood well out of the town of that date, and covered an area of about 1½ acres, having a frontage to Ormeau road of 220 feet, and a depth of about 300 feet. The retort house was 100 feet long by 36 feet wide, and contained 45 cast iron retorts, from which the possible make could not have exceeded 100,000 cubic feet per day, while the actual production was probably not nearly so much even in midwinter. The purifiers seem to have been boxes 4 feet square, and the station meter passed 50 cubic feet per revolution. The largest of the six meters now in use is capable of passing 57 times that quantity. There were three gasholders, each 40 feet diameter, 15 feet deep and containing 18,500 cubic feet each, or 55,000 cubic feet in all; the latter amount may be taken as fully equal to the largest day's consumption. During last winter the largest day's consumption was about 133 times as much, amounting to 7,500,000 cubic feet.

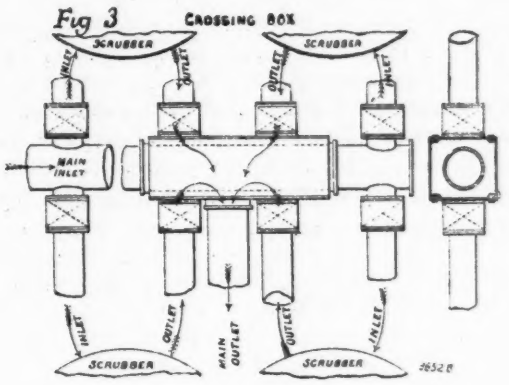
A great impression seems to have been produced by the method of building the chimney, as well as by what was considered its great height, namely, 97 feet. An old doggerel ballad, which was sung in the streets shortly after the inauguration of the works, truthfully refers to "the great Robert Hall, who built the gas chimney without scaffold at all."

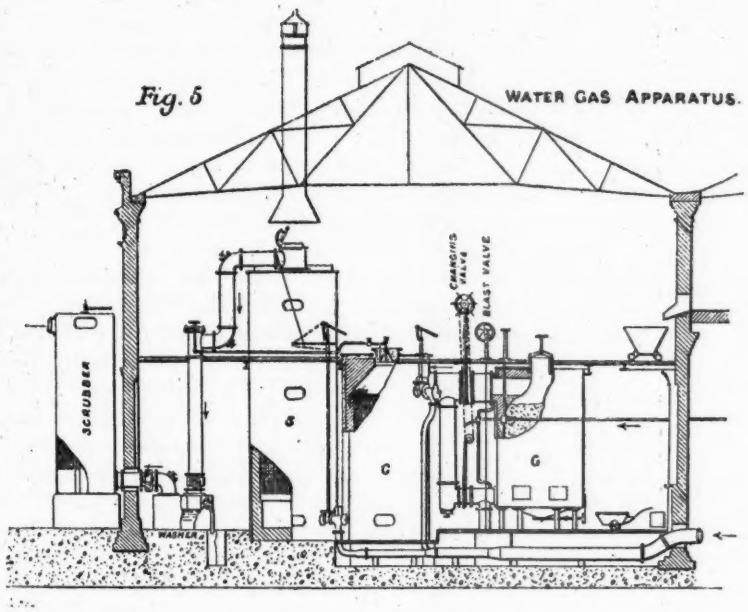
An unprofitable period of difficulties was happily terminated in 1852, when the management was intrusted to the writer's father, to whose patience, perseverance and energy it is due that the concern was rescued from the quagmire of financial failure and placed on so sound a foundation that when it was purchased in 1874 for the community the operations were being so carried on as to render the transfer a great public benefit.

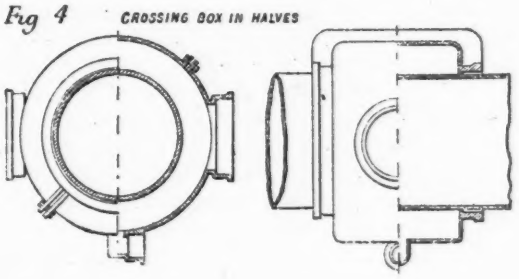
Extensions.—In 1852 the gasholder accommodation began to prove insufficient, the full storage being about 290,000, and the maximum day's consumption about 430,000 cubic feet; and within a month of the new manager's appointment he was called upon to undertake an extension in this direction, which was carried out during the following year. The new gasholder, at that time considered colossal, was 100 feet in diameter, rising to a height of 50 feet, and containing when full about 380,000 cubic feet, which is equal to about 25 minutes' supply during the period of present maximum consumption. It is still at work and rendering excellent service. The producing and purifying plant next became too small, so that extended retort houses and purifiers had to be provided. As regards the former, after utilizing an old coal shed as a retort house, and tinkering up the old benches, it was thought desirable to build an entirely new house over the top of existing benches, and to cover new ground for further expansion in this department. The obligation to keep things going rendered it necessary, however, to follow the lines of the old house, a necessity which has resulted in great inconvenience of working. A set of purifiers, each 10 feet square, had been added, but served only for a short time to stave off trouble, and therefore it was resolved to add another set of 12-foot boxes, which it was then supposed would meet all requirements. By 1861 the daily output had reached a maximum of over 1,000,000 cubic feet, and storage had again become insufficient. It was accordingly resolved to put











up a still larger gasholder, 110 feet in diameter, rising 52 feet, and holding, when full, about 560,000 cubic feet, which was placed on the space occupied by four of the six small holders; and the tanks of the remaining two were converted into tar and liquor wells. While this work was being carried out, an accident occurred which momentarily jeopardized the supply of gas to the town for the whole winter. The wall of the new tank fell in, carrying with it the wall of the neighboring tank and the gasholder as well. Fortunately the community were spared from the threatened catastrophe, and the two tanks were rebuilt, the one which was replaced being made larger than the original, so that by the following year the storage for gas had been increased to about 1,350,000 cubic feet, the daily maximum being nearly 1,250,000 cubic feet.

Coal Supply.—Up till 1865 all the coal used in the works had been carted from vessels at the quay, and the low cartage rate of only 14 cents per ton gave no inducement for a change. Gradually, however, coal vessels had to discharge at a greater distance from the works, and wages and other charges began to increase, causing the cost of cartage to rise from time to time until it reached 29 cents per ton. All coal was then received into barges and brought alongside the gas works wharf, where it was discharged as before by means of bags, which were carried from the barges to carts and from the carts into the retort houses and stores. To facilitate delivery the retort houses were placed as near the front gate as possible—a somewhat undesirable arrangement, which would not have been adopted if it could in any way have been avoided. The cost of transit from the wharf was 16 cents per ton, and the lighterage 10 cents, so that a saving was effected, but only to the trifling extent of 2 cents per ton. The congestion caused by the constant stream of coal carts entering and leaving the gate, and impeding the vehicles coming for coke or bringing lime, etc., into the works, became each year more serious, and showed that the time was near when it would be impossible in this way to bring into the premises sufficient coal for a day's working.

Elevated Railway and Cranes.—Meanwhile another gasholder was erected of 150 feet diameter, which, when fully elevated, contained upwards of 1,000,000 cubic feet; and a still larger one, capable of holding 1,500,000 cubic feet, was completed in 1874. Two years later the first attempt was made to deal with the congestion consequent on the coal delivery, by the establishment of an elevated platform and railway served by hydraulic cranes at the wharf, which was reconstructed. The rails were carried into every division of the retort houses; and by means of a hoist the wagons were elevated to a still higher level of rails running through the roofs of existing coal sheds. The trouble experienced in carrying out this work was great, and the cost about $30,000, while the saving effected was only about 4 cents per ton. Its real usefulness, however, lay in doing away with all the former bustle in the yard, when the utmost that could be taken in per day was only 240 tons, whereas now 700 tons can be taken in with ease, working only one crane, and the yard is freed from this source of congestion.

Stoking Machinery.—In 1884 it was decided to make a trial of stoking machinery in the retort house. The buildings were unsuitable for machines, on account both of their narrowness and want of length; and in one division only has it been found practicable to work the plan, which is that of Mr. John West, of Manchester. The coal is broken into small pieces in the coal shed, and elevated on to a high-level band, whereon it is conveyed to hoppers situated at the end of the retort house, and from these the charging machines are fed. The machinery is actuated by compressed air at a pressure of about 70 pounds per square inch. Similar machines of improved make have been provided in the retort house not yet in use; these will be worked by ropes, the power being obtained from engines placed near the end of the house.

Hydraulic Power.—With the advent of hydraulic power numerous appliances were rendered desirable and practicable. Capstans for coal and coke haulage, lifts for covers of purifiers, cranes for coke storage, and small hoists for various purposes have been put up, all of which are worked by water power supplied by a small steam engine having a pair of cylinders of 14 inches diameter and 12 inches stroke. The steam pressure is 40 pounds per square inch, and the hydraulic pressure 700 pounds. Two accumulators are in use; one of 8 inches diameter with 11 feet rise, and one of 12 inches diameter with 15 feet rise. The increased appliances were at once called upon to meet increased and increasing demands.

The consumption of gas had risen from 416 million cubic feet in 1874 to 562 million in 1881; and the addition of still another gasholder of 190 feet diameter, with a rise of 90 feet and a capacity of 2,400,000 cubic

feet, brought up the total storage capacity to 6 million cubic feet. Gradually, too, the new retort houses were brought into use, until this reserve became part of the daily working in winter, and no margin remained for emergency. The rush of gas was so great that the purifiers were at times quite overpowered, and blew their water seals, causing serious loss of gas and great risk; for on one occasion at least the escaping gas ignited, and but for the prompt action of the foreman there might have been a serious calamity.

Overhead Purifiers.—Every addition of buildings or apparatus in order to produce more gas meant the occupation of valuable space. If the land question seems to have been always a burning one in Ireland, it has certainly been so in the later history of the Belfast Gas Works. As the space originally intended for purifiers was the only ground on which a retort house could be built, in 1891 a new structure with most modern settings and appliances was commenced thereon, and is now ready for work; but other appliances about to be described have thus far prevented it from being brought into use. It forms practically a third complete section of the works, being provided with a full complement of condensers, exhausters, etc. To make up for the loss of ground intended for purifiers, it became evident that there was only one way out of the difficulty, and that was upward. Accordingly a set of overhead purifiers has been designed and erected, Fig. 2. The structure is mainly of steel, of which some 1,200 tons were used. The upper floor, which is 150 feet by 120 feet, is reached by means of two hydraulic elevators, and will afford storage for upwards of 2,000 tons of lime when trimmed to a height of 3½ feet. The lime is taken up and slaked on the upper floor, and when properly prepared is discharged through apertures in the floor by means of canvas hose-pipes about 10 inches in diameter. This method of distributing lime has been used successfully for years past in Glasgow and elsewhere. When it is necessary to change the purifying material, that which is spent is discharged to the ground level through apertures in the bottoms of purifiers. This work has been carried out in a highly efficient manner by the contractors, Messrs. Hanna, Donald & Wilson, of Paisley.

Pipes and Crossings.—In bringing up the establishment to its present producing power, it will be readily understood that the connections both over and under ground formed no small part of the difficulties to be overcome. The pipes were becoming not only more numerous, but larger also; the former connections, of which the largest did not exceed 12 inches in diameter, had to be replaced by sizes increasing from 18 inches up to 36 inches. The lines too had to cross frequently, necessitating great depth of excavations and of mains, and rendering the draining of the latter difficult. About 1865, when a problem of special difficulty presented itself, the writer was fortunate enough to hit upon a simple plan for accomplishing the desired end. Fig. 3 shows in plan the position of the vessels, and the method of their connection with the main. While the inlet pipe is connected in the ordinary way to the scrubbers, it will be observed that the outlets from the latter pass into a box which surrounds the inlet, and it is from this box that the main outlet issues. So useful did this method prove that advantage was soon taken of it in a modified form for the crossing of existing mains by constructing a crossing box in halves, as shewn in Fig. 4, with flanges set at an angle of 45° from the horizontal line, so as to afford room for the inlet and outlet sockets. The latest of these crossing boxes have been fixed in the connections from the water gas extension, which have thereby been rendered a comparatively simple matter.

Water Gas.—All these extensions and schemings, however, would have availed but little had not an invention been fortunately met with some four years ago, which is due to the ingenuity and ability of American gas engineers. The making of water gas carbureted with liquid hydrocarbons was attempted as much as 50 years ago, but without success; at that time the bulk of the hydrocarbons never got beyond the vapor stage, and on cooling the gas they promptly resumed the liquid form. Various processes were tried without success; and indeed, with coal plentiful and cheap, and labor moderate, there was no idea in this country of carbureted water gas as a possible competitor of coal gas. Different conditions, however, prevailed in the United States, where coal was dear and labor expensive, while crude oils and naphtha were to be had at low rates. Naturally, therefore, the gas engineers turned their attention to the manufacture of water gas and its enrichment by means of petroleum distillates. Many of the earlier devices were clumsy and unsatisfactory; but the result of years of experimental work was the modern Lowe system. Knowing that this system would at least produce a large quantity of gas on a small space, and would furnish an outlet for coke instead of producing more, the writer four years ago consulted Messrs. Humphreys & Glasgow, and, the project being warmly supported by the then Chairman of the Gas Committee, Mr. C. C. Connor, an order was given them for an apparatus equal to the production of 1½ million cubic feet per day.

This apparatus, shown in Fig. 5, was set to work at Christmas, 1893, and has been in constant daily use from that date. It is remarkable alike for its great simplicity and for its large efficiency. Gas making can be stopped at any moment and resumed at a minute's notice; and a set which has been lying off for some days can be turned into full work in half an hour, while a set which has been so long out of work as to have become quite cold can easily be set going in three or four hours. Into the first vessel *G*, known as the generator, coke is piled to a working depth of 6 feet to 7 feet, and, being ignited, is brought to a high temperature by means of a powerful blast. The products, consisting theoretically of carbonic oxide and carbonic acid, in varying proportions, together with the nitrogen of the air, pass into the second vessel *C*, known as the carbureter. At the entrance to this vessel secondary air is admitted, which effects the partial or complete combustion, as may be desired, of the carbonic oxide into carbonic acid. The resultant gases pass on into the superheater *S*, at the entrance to which secondary air is again available, in order that complete combustion of the carbonic oxide may be effected here, if it has not already been accomplished in the carbureter. The final products escape into the atmosphere by means of the stack valve, which is left open. This portion of the process is known as "blowing," and its object is to get up the heat, firstly, in the generator, so as to secure the breaking up of the steam in the succeeding operation of gas making or "running," and, secondly, in the carbureter and superheater, so as to effect the proper "cracking" or gasification of the oil. These two vessels are filled with checkerwork of firebricks so laid as to baffle the gases in their progress; the spaces left between the bricks are about 2 inches wide. By the spent heat of the generator and the combustion of the carbonic oxide this brickwork becomes heated; and when the temperature reaches about 1,700° F. gas making or "running" may commence. For this purpose the blast is now shut off, steam of about 100 pounds pressure is turned on into the generator, and the stack valve is closed down. The steam follows the same course as the blast, and in its passage through the hot coke it gives up its oxygen to form carbonic oxide, whereby the hydrogen is liberated; and there is thus delivered into the carbureter a gas consisting theoretically of equal volumes of carbonic oxide and hydrogen, which has no illuminating value, but a high heating power. On its entrance into the carbureter, a douche of petroleum oil is sprayed upon hot iron bars placed over the brick checkerwork. This oil is preferably heated beforehand by being passed through a delivery pipe which is carried through the main outlet of hot gas. It is at once vaporized and picked up by the non-illuminating water gas; and in its passage the mixture comes in contact with the hot checkerwork, whereby the complete "cracking" or gasification of the oil is effected, which is the sole purpose of the carbureter and superheater. Passing through the main outlet, which is sealed in water so as to prevent any return of the gas, the carbureted water gas is led on into the ordinary cooling and purifying apparatus, to be there treated in the same way as ordinary gas. The process of "running" is necessarily one of cooling also, and if it were continued too long, the coke in the generator would become too cool to break up the steam, and the surface of the brick checkerwork would grow too cold to effect the "cracking" of the oil. Therefore, when gas making has gone on for about 7 minutes, the steam is shut off, the stack valve opened, and blowing is resumed for about 4 minutes, by which time the normal heat in the three vessels is restored, and another spell of "running" commences. After four "runs" have been made, the generator requires replenishing with a supply of coke, which can be fed in through the charging hole at top in about half a minute; and about once in every 12 hours it requires clinkering—a warm and unpleasant operation, which, however, occupies only about a quarter to half an hour.

Advantages of Water Gas.—In addition to the ease with which water gas apparatus can be put into or out of action, there are other advantages arising from its use, among which may be specially mentioned the following:

Economy of Space.—The ground occupied by the water gas apparatus need not be more than one-eighth of that required for retort houses capable of producing an equal supply of gas; and the oil storage tanks occupy about one-fifteenth of the area which would be required for an equivalent coal storage, assuming the coal to be piled up to a height of 15 feet.

Economy in Outlay.—The cost of water gas apparatus would hardly exceed one-half of that required for coal gas works, while the charges for maintenance and repairs are comparatively trifling.

Ease in Dealing with Raw Material.—By means of steamers' pumps

2,000 tons of oil can be pumped into the storage tanks in 36 hours, through 2 miles of 6-inch pipes. For gas making this is the equivalent of 20,000 tons of coal, which would be equal to the cargoes of 50 ordinary steam colliers. The labor involved in transferring this quantity of coal into barges, carrying it to the works, and distributing it in the retort houses and stores, will be readily appreciated.

Effect on Residuals.—The water gas system gives control as regards the production of coke, and also provides profitable use for a portion of that which is made in the ordinary way. It is possible, indeed, to arrange such a balance of the two systems as would leave no coke for sale, but it is not likely that such a method of working would be wise or profitable.

Rapidity of Production.—The water gas is made in immense volume, and from hour to hour can be relied on to undergo but trifling variation as to quantity or quality. When making gas of 24 to 26-candle power, each run of seven minutes produces about 9,000 cubic feet; so that one set of apparatus is capable of yielding over 900,000 cubic feet in 24 hours. During the past season one set has produced on several occasions 1,000,000 cubic feet in 24 hours.

Labor Saving.—The economy in this respect is great. Each operator will produce in an 8-hour shift upwards of 300,000 cubic feet of water gas, whereas the make of coal gas rarely exceeds 18,000 cubic feet per man.

Cost of Gas Production.—At present it is difficult to estimate what this would be to any concern depending on the day's market for supply of oil. In comparison with such qualities of gas as could otherwise be produced only by the use of cannel, there would certainly be a marked economy. The cost of oil to the Belfast Gas Works for the year ending June 30, 1895, was 4.428 cents per gallon; and at this rate a saving was effected in cost of production of 3 cents per 1,000 cubic feet over the whole make, both of water gas and coal gas, the average production of water gas being one-third that of coal gas. The current year it is trusted will show still better results, but as these would be obtained with oil purchased under peculiarly favorable circumstances, the figures even if available would be misleading. The writer, however, has not found any reason to change the opinion expressed in his paper read to the Incorporated Gas Institute in June, 1894, that with oil at 5 cents per gallon carbureted water gas of 21-candle power can be produced for less money than 17-candle power coal and cannel gas.

Extension of Water Gas System.—Carbureted water gas had been in use in London for some years prior to its introduction into Belfast; but it seemed to be regarded there rather as a means of meeting an emergency than as a regular factor in the daily make; and the stated cost of the water gas was so high as to offer but little inducement towards the adoption of the plan. Since the experience in Belfast with the most modern apparatus has been made known, water gas has been taken up seriously in no fewer than 15 other cities and towns in the United Kingdom, notwithstanding the sudden rise in price of oil; doubtless but for the latter the number would have been considerably increased.

In every place where the apparatus has been got into work it seems to have given entire satisfaction.

In Belfast, after 18 months' working, it was decided to supersede gradually one of the old retort houses with water gas apparatus. At present one bench of retorts has been removed, which was capable of producing 900,000 cubic feet per day; and part only of the space thus acquired has been occupied by four sets of water gas apparatus capable of turning out four million cubic feet per day, or 4⅓ times as much as was produced by the retorts.

Growth of Gas Production.—Meanwhile the demand is still going on apace. Fifteen years ago these gas works were pronounced commercially dead, while yet the consumers have continued to demand from them all the work and service expected only from a flourishing vitality; and a power of growth has been developed, not usually manifested by a moribund concern. Measuring this growth in millions of cubic feet per annum, the progress in decennial periods has been as follows:

Year ending June....	1825	1835	1845	1855	1865	1875	1885	1895
Millions of cubic feet..	10*	24	51	109	248	418	718	1,169

*Estimated.

This growth is still continuing; and, notwithstanding prophetic warnings that the gas industry is already on the wane, the writer ventures to maintain that it has not yet nearly reached its zenith, and to predict that for many a long year the citizens of Belfast will continue to regard with appreciative interest the familiar row of chimneys along the Ormeau road which pertain to the Corporation Gas Works.

Dr. H. Lux on the Lighting of Berlin.

The London *Journal* says that no one was more capable of collating the immense mass of official documents and statistics relating to the public lighting of Berlin than Dr. H. Lux, the editor of the *Zeitschrift für Beleuchtungswesen;* and the volume of nearly 500 imperial octavo pages now before us[1] testifies to the conscientious manner in which he has performed his self-imposed task. The book should have a wider circle of readers than that to which its title would naturally give it access; for in reality it presents an excellent survey of the present position of gas manufacture and of the supply of electrical energy throughout Germany. Berlin is the largest, and it is also a typical German city; and, especially in the matter of the lighting industries, it serves to illustrate principles and methods that have a wider field of application. Hence we offer no further apology for briefly reviewing seriatim the contents of Dr. Lux's work.

The first chapter is historical, and divides the story of the lighting of Berlin into three sections. The first section embraces the period from 1680, when the first attempt to light the streets was made, to 1825, when a contract was entered into with the Imperial Continental Gas Association to light the town—partially by gas, partially by oil lamps. The second section covers the period from 1825 to 1860, from which year very great strides were made towards the improvement of the public lighting. The third section brings the story up to 1895.

The second chapter deals with the production of gas in Berlin. There are five municipal works, and three owned by the Imperial Continental Gas Association. The make of gas in the year 1893-94 was 3,630 million cubic feet at the municipal works, and 1,180 millions at the Association's works. Berlin and the suburbs are now estimated to consume about 7,000 million cubic feet of gas a year. Upper Silesia furnishes the greater part of the coal carbonized at the city works. About one-fiftieth part only comes from England. The average make of gas per mouthpiece per day during the past year was 9,645 cubic feet. The retorts were drawn and recharged six times daily. Of the entire number of retorts in action, 91.3 per cent. had generator firing. The majority of the new settings have furnaces of the improved Munich pattern. Dr. Lux explains very lucidly, by the aid of excellent illustrations of the Munich setting, the application of the regenerative system to retort furnaces. In the recently erected houses, Morton's self-sealing retort lids have been adopted. Drawing and charging are still done by manual labor at all the city works; but Dr. Lux illustrates the mechanical stokers in use at the neighboring works at Charlottenburg. A tubular condenser with water circulation is the only type mentioned, and it is possible that the forced economy of space precluded the use of atmospheric condensers. But we believe German gas engineers do not regard the latter with favor under any conditions. Bog oxide is the only purifying material now used. Körting's steam jet exhauster is employed at one works, and reciprocating exhausters at the others. Those of the rotary type appear to pass unnoticed. The coal carbonized in 1893-4 gave the following percentages by weight of products: Coke, 62.1; tar, 5.03; ammoniacal liquor, 9.8.

Distribution is dealt with in the third chapter. The municipal works supply 167 miles of mains, and the Association's works, 70 miles. The average consumption per head of the population decreased slightly during last year, owing to the more general adoption of the Welsbach light. The latest annual return gives it as 2,860 cubic feet. The leakage amounted to 4.49 per cent. of the production, and was therefore higher than in many of the other large towns of Germany. There are now 1,553 gas engines in use.

The fourth chapter deals with the application of gas to lighting purposes, and incidentally with photometry. The English sperm candle is used for testing; but the consumption of sperm is ignored and readings are invariably made at a flame height of 45 mm. (1.77 inches). The gas under examination is burnt in an argand burner with 32 holes at the rate of 150 liters (5.297 cubic feet) per hour. The average illuminating power for the year of the gas sent out from the municipal works was 17.3 candles; or corrected to a consumption of 5 cubic feet per hour, 16.3 candles. Dr. Lux mentions several other standards of light, and also describes, with the aid of illustrations, a radial photometer. Some special portable apparatus for taking the illuminating power of street lamp burners in situ is also mentioned. The gas is examined for ammonia by a saturation test which indicates a quantity exceeding 0.75 grain per 100 cubic feet. Sulphureted hydrogen is looked for, and the amount of carbonic acid in the gas is roughly determined. No notice is apparently taken of sulphur compounds other than sulphureted hydrogen. In June, 1895, there were 25,504 gas

1. "Die offentliche Beleuchtung von Berlin," Von. Dr. H. Lux, Berlin: 1895.

burners employed for street lighting, of which the greater number were of the ordinary batswing type, each consuming about 7 cubic feet of gas per hour. There were only 55 Welsbach burners in use for street lamps. Some of the standards and lanterns are of a highly ornamental character. Several types of regenerative and incandescence burners are lucidly described. A few burners are furnished with electric igniting apparatus.

The fifth chapter deals with the administration of the Gas Department. The price of gas for lighting purposes is at the rate of $1.13 per 1,000 cubic feet; but if supplied for other purposes by a separate meter, the price is only 70 cents. Meter rents are charged. The cost of public lighting in Berlin has steadily increased year by year.

The next chapter deals with the production of electrical energy at the Berlin stations. Electric lighting was virtually not introduced until 1883, when a concession was granted to the German Edison Company to light a portion of the city. In August, 1885, the first large works were opened. They had six machines, giving a total of 900 horse power. The electrical stations can develop 20,100-horse power. After very complete descriptions of the plant in use at the various stations, we find the following statement, which must be highly gratifying to the inhabitants of Berlin: "In consequence of the technically superior disposition of the plant and of the unsurpassed system of working, the Berlin central stations attain the highest commercial efficiency. They yield at the place of consumption, on an average throughout the year, a current of 254 watts for every pound of coal consumed. No other central station in the world has achieved such a result."

The seventh chapter treats of the distribution of electrical energy. The apparatus essential to it is described at length, and an elaborate plan of the city, showing the area of supply, is given. Transformers, switches, meters and cables are all fully dealt with, and the precautions taken to minimize the risk of accidents are mentioned. We notice that possible danger from the formation of explosive gas from the moisture in the culverts is one case considered; and our own electrical engineers would be well advised if they studied the precautionary measures adopted in Berlin. Space in the street boxes and culverts in which coal gas might accumulate is avoided as far as possible, and when it must inevitably be left, ample ventilation is provided. In the succeeding chapter, the application or consumption of electrical energy is dealt with. The total annual production for 1893 4 was equivalent to 7,556,787 kilowatt hours, of which 15.8 per cent. was unaccounted for. The price per kilowatt hour for lighting purposes is now 60 pfennige (about 14 cents), subject to certain abatements to large consumers.

The ninth chapter treats of the actual lighting. We find in it a comparison—based on reasonably fair assumptions—of the relative duties of various systems of lighting per unit of energy consumed. The following are the figures: Large batswing gas burner, 90; large argand gas burner, 106; electric incandescent lamp, 170; Schülke's regenerative gas burner (26.5 cubic feet per hour), 200; incandescent gas light, 520; electric arc light, 1,000. The efficiency of the incandescent electric lamp is very low, and this is the reason of its replacement in many cases by the incandescent gas light. All the more important examples of standards and candelabra in use for the electric light in the streets and public buildings of Berlin are described by Dr. Lux, and numerous illustrations are given.

In the next chapter, the administration of the electrical works of the city is dealt with. The profit realized in 1894-5 sufficed for a dividend of 12½ per cent. on the subscribed capital.

In the eleventh chapter, various means of lighting are briefly considered. Petroleum is the chief, and several patterns of regenerative mineral oil lamps are described. Oil gas and naphtha vapor lamps are touched upon, and there are a few remarks on public illuminations.

In the twelfth chapter, the author gives statistics of the lighting of all towns in Germany of more than 50,000 inhabitants. It should prove invaluable to those seeking such information for purposes of comparison.

The final chapter treats of the illuminating effect of the various lamps in use. The following values for some units of light are stated to be from recent determinations: Violle's platinum unit, 18.5 English sperm candles, at a flame height of 45 mm.; the carcel unit, consuming 42 grammes of oil per hour, 8.9 candles; the German paraffine candle, at a flame height of 50 mm., 1.13 candles; the Hefner unit, at a flame height of 40 mm., 0.94 candles. This chapter is perhaps the most valuable one in the book. There are numerous diagrams showing the degree of illumination of a road by various burners at different distances apart. These are worthy of the attention of everyone concerned in the lighting of streets and open spaces. The ideal public lighting is considered to be that which enables medium sized print to be read at any position in a street, and probably this ideal is attained only in Paris.

Much arduous labor must have been bestowed upon the compilation of this really valuable work, and Dr. Lux has earned the gratitude of his fellow technicians for the devotion of his abilities to it.

Test of an Isolated Electric Lighting Plant.

[By Mr. S. A. Beyland, in the *Scientific Magazine* of the University of Tennessee.]

This article contains the results of tests of the gas engine and lighting plant belonging to the First Methodist Episcopal Church, of Knoxville, Tenn., and was made in order to ascertain the economy of such a plant in actual service as run by the janitor. No precautions were taken to have the machinery in better order than usual, and the gas was measured by the regular meter furnished by the Gas Company by which the bills were made out.

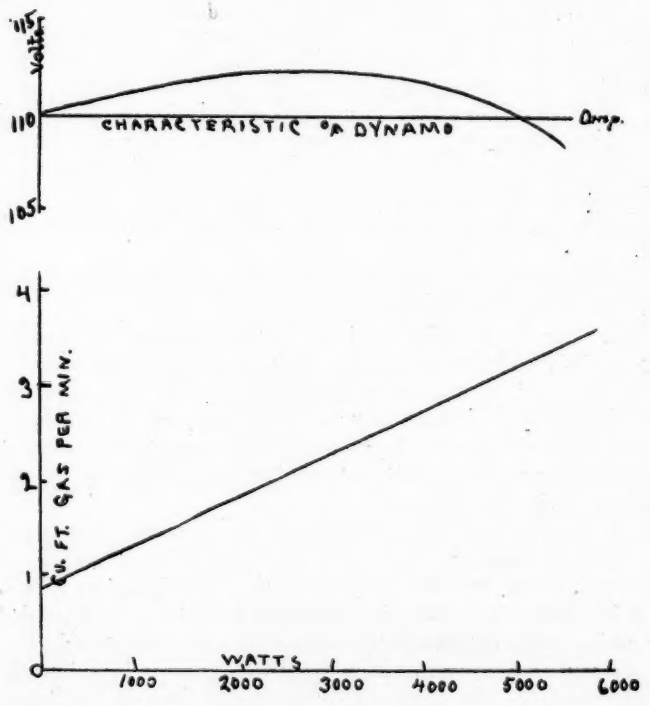
The tests were made by the engineering students of the University, under the supervision of Dr. Perkins. They continued for about three hours.

Location: The engine and dynamo are located in the basement of the church, and in a cramped position between the wall and the furnace used for heating the building. During these experiments, on account of starting the fires, the temperature of the room rose from 60° to 82°.

The switchboard was on the opposite side of the building from the dynamo, on the main floor, and all the branch circuits were fed from this point, thus introducing a large drop in pressure, as mentioned below.

Current and E.M.F. were measured by Weston instruments. The ammeter read only to 50 amperes. Above that point current was reckoned by the number of lamps in circuit. Speeds were measured by a tachometer, and quantities of gas by the meter in regular use furnished by the Gas Company.

The engine was the regular Otto 10-horse power machine, fitted with a governor controlling the speed by regulating the number of explosions. This governor worked well at high loads, but at very light loads the speed would frequently drop five revolutions or more below normal before an explosion would occur. The dynamo was rated at 110 volts and 60 amperes. It was compound wound, and the characteristic is

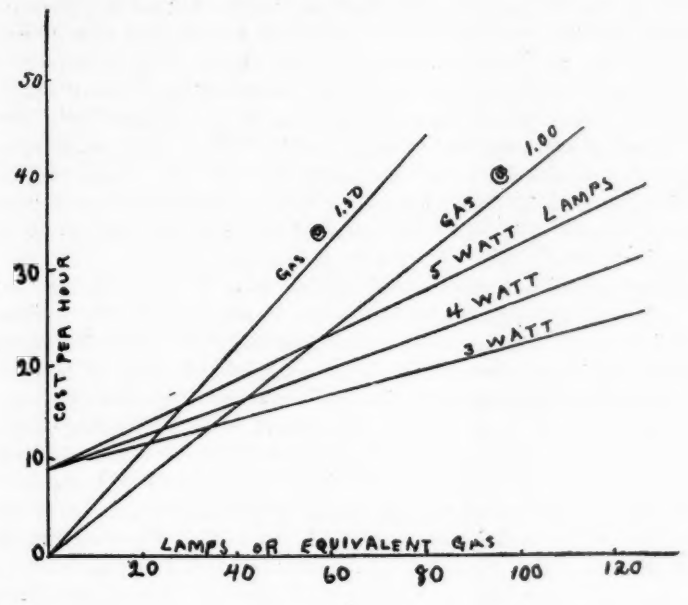


shown in an accompanying diagram. For further regulation a rheostat is placed in the shunt field coils, which is cut out at high loads in order to compensate for the excessive losses in the feeders. The dynamo was run at a speed of about 1,550 revolutions per minute. During the course of the test additional lamps were thrown on until the current rose to 70 amperes, while the temperature of commutator increased from 60° to 122°, the temperature of the room increasing during the same time to 82°, as above mentioned. With a current of 50 amperes a drop of 7.7 volts was noted between dynamo and switchboard, indicating a resistance of about 15 ohms. The wire was evidently too

small, causing a loss of 1 per cent. for 10 lamps, 5 per cent. for 50 lamps, and 10 per cent. for 100 lamps. The loss in branch circuits was also quite large, but was not determined, the lamps in the main chandeliers being inaccessible. The lamps used required about 80 watts, or 5 watts per candle power if we take them at their rated (16) candle power.

The consumption of gas above that necessary to run the engine and dynamo unloaded increased quite uniformly with the load.

The accompanying figures show the cost of lighting per hour of actual plant for different loads, also cost for same plant if 4 watt lamps



or 3 watt lamps were used. Lines are also drawn showing the cost of the same illumination using gas, the gas being taken at 20 candle power as given by the regular tests of the Gas Company. The gas is reckoned at $1 per 1,000 cubic feet, and at $1.50 per 1,000, because the local company charges the latter price for gas used for illumination, while for gas engines and all fuel consumption it charges $1.

From a consideration of the figure it will be seen that, where only a small number of lights is required, gas used directly is much cheaper. Above 30 lamps it is decidedly cheaper to use the gas for fuel in driving the dynamo. Thus, if it is desired to illuminate but one or two of the smaller rooms, the gas burners are used; but if the main audience room or the entire building is to be lighted, the dynamo is put in operation.

Number of Lamps.	External. E.	I.	W.	Cu. Ft. Gas per Min.	Gas per Lamp Hour.	Gas per Watt Hour.	Gas per 64 Watt Hours.
Engine with no load.....				1.25	.....	.. ....	....
Belted to dynamo—no current.....				1.54	.....	.....	.....
3	110.5	2.13	225	1.82	27.3	.485	31.00
31	112	22.6	2,531	2.83	5.3	.067	4.23
51	112	38.0	4,256	3.61	4.16	.051	3.26
71	110	(51.8)	5,702	4.29	3.57	.045	2.88
67	110	49.0	5,390	4.17	3.68	.046	2.94
80	108	.....	6,296	4.35	... .	.....	.....
	Change	in rheo	stat shu	nt coil..	.....	.....	.....
	110	58.3	6,471	4.84	3.58	.044	2.86
98	110	71.3	7,843	5.36	3.25	.041	2.52

Current in shunt coil, 1.35 amp. Loss, 1.43 watts.

Drop to switchboard with 70 lamps, at 50 amp., 7.7 volts. Loss, 385 watts, or 17.3 c. f. gas per hour.

The Action of Heat on Cement.

Mr. J. S. Dobie, in an article contributed to the "Digest of Physical Tests and Laboratory Practice," has the following to say respecting the action of heat on cement:

The modern tendency toward large and high buildings, with a skeleton structure of steel, has made the question of fire prevention and protection one of the most vital importance to architects, manufacturers, engineers and builders in general. Countless experiments have been made to devise some means of preventing iron and steel columns and girders from buckling under great heat. Plainly, the only way this can be done is by so protecting the metal that heat cannot come in contact with the metal surface.

Experiments have also been made, and numerous schemes introduced, to devise some means of making a floor between the girders that will withstand the action of fire, and so prevent a fire, even if started, from spreading from one flat to another. Hollow tile, brick and terra cotta have been tried with indifferent success; and at present the tendency is toward using Portland cement or concrete as a protection for iron work. It is the purpose of this paper to show what really may be expected from a mass of concrete or cement when subjected to great heat.

In making these tests three brands of cement were used—two Canadian brands: "Star," manufactured at Deseronto, and "Samson," from Owen Sound; one brand, "Jossen," of Belgium manufacture. These cements were thoroughly tested for fineness, strength, and "blowing" before using, and were found to be first-class. The "Star" and "Jossen" were comparatively slow-setting, and the "Samson" set very rapidly.

Tests were made upon neat briquettes and sand briquettes, mixed in proportions of 1 sand to 1 cement, 2 sand to 1 cement, and 3 sand to 1 cement. The age of the briquettes varied from two months to about four years. Over 200 briquettes were used in making the tests.

The briquettes were heated in a small assay furnace, heated by a large gas burner, and which gave a range of temperature of from about 650° F. to about 1,775° F.

The temperatures were determined by means of a water calorimeter; the temperature of the furnace being obtained from the rise in temperature of a pint of water, in which had been immersed an iron ball of known weight, and which was heated to the temperature of the furnace. The temperatures given are approximately correct. The calorimeter gave good results—different readings under the same conditions rarely differing by more than 10° or 15°, which is very close for such high temperatures.

On heating the briquette and removing from the furnace, the first thing noticed was a loss in weight in the briquette; and almost all neat briquettes showed cracks, some large and some small. Some sand briquettes also showed cracks, but not to the same extent as in the neat briquettes; but there was no exception to the change in weight. This loss in weight is due to the fact that the hardened cement is a compound of hydrated crystals of aluminum, silicate and calcium silicate, and the heat drives off the water of crystallization, and the loss in weight corresponds to the amount of water of crystallization driven off by the heat. Now, since the crystals depend upon the water for their formation, it is evident that when the water is removed the crystals are destroyed and the cement ruined. Such was found to be the case in every instance.

The briquettes, after cooling sufficiently to allow handling, were broken in the testing machine, the load being applied at the rate of about 400 pounds per minute. The result showed a marked decrease in the tensile strength, as reference to Tables I. and II. will show; and, under the best conditions, this loss in tensile strength showed an approximate proportion to the loss in weight. Briquettes which lost 19 or 20 per cent. in weight, which is practically the amount of water required for proper crystallization, were practically unable to resist any load whatever, and in very few cases possessed 10 per cent. of their original strength.

The effect of different temperatures was rather peculiar. Briquettes placed immediately into a temperature of about 1,775° F., showed a very great loss in strength for a very small loss in weight, and did not appear to follow this law of proportion between losses of weight and strength, at least not nearly so well as briquettes treated differently. When the briquettes were gradually heated, however, and allowed to slowly rise to the temperature of the furnace, this law was followed quite closely, as reference to tables will show. This is accounted for by the fact that the cold briquette on being placed in the furnace at such a great heat, is immediately subjected to very considerable internal stresses, due to the expansion of the outside of the briquette before any water of crystallization at all is driven off. Briquettes heated gradually were not subjected to these internal stresses to nearly the same extent as those which were heated very suddenly.

An attempt was made to discover, if possible, a critical temperature to which it would be possible to subject the cement without danger of injury to the crystals, and where the cement would retain its cohesive powers. It was found that, if such a temperature existed, it was below the lowest temperature generated by the furnace, which was considerably below red heat. The lowest temperature had the same effect as the highest, excepting, of course, that with the low temperature a longer time was required to effect the same reduction of weight than with a

TABLE I.—*Results of 26 Briquettes Heated Suddenly.* (Temperature, 1,775° F., approximately.)

Weight in Grams—Before.	Weight in Grams—After.	Per Ct. Lost.	Tensile Strength—Before.	Tensile Strength—After.	Per Ct. Lost.
*140	125	10	530	190	64
*139	117	15	530	200	62
*140	115	17	530	185	65
*139	113	18	530	53	90
*140	125	11	530	180	66
*140	132	5	530	235	55
*139	137	1	530	330	37
*140	127	13	530	140	73
*139	133	2	530	280	47
*139	112	19	530	15	97
*140	121	13	530	155	70
*138	119	13	530	145	72
*135	131	2	930	0	100
†133	118	11	930	20	97
†132	Dropped from tongs and broke on floor.				
†132	123	6	930	50	94
†132	118	10	930	20	97
†134	128	4	930	23	97
‡139	125	9	515	85	83
‡138	128	7	515	75	85
‡140	134	4	515	122	76
‡137	135	1	515	200	61
‡138	131	5	515	97	81
‡138	135	1	515	185	64
‡140	112	19	515	0	100
‡137	113	17	515	10	98

*"Star" brand. †Briquettes, four years old, brand unknown. ‡"Jossen" brand.

TABLE II.—*Results of 21 Briquettes Heated Very Gradually and Broken.* (Maximum Temperature, 1,000°–1,025° F.)

Weight in Grams—Before.	Weight in Grams—After.	Per Ct. Lost.	Tensile Strength—Before.	Tensile Strength—After.	Per Ct. Lost.
*139	132	4	530	395	25
*138	130	5	530	390	26
*140	128	8	530	348	34
*140	129	7	530	351	33
*138	126	8	530	327	38
*138	120	12	530	152	71
*139	116	16	530	73	84
*138	113	18	530	29	94
*140	119	14	530	110	79
*139	125	10	530	237	55
†137	129	6	515	348	32
†139	130	6	515	348	52
†140	133	4	515	398	22
†139	127	9	515	232	49
†140	120	14	515	182	64
†138	136	1	515	440	14
†139	134	3	515	400	22
†140	121	13	515	195	62
†139	117	15	515	130	74
†140	122	12	515	193	62
†139	112	19	515	10	98

*"Star" brand. †"Jossen" brand.

higher one. The lowest temperature necessary to destroy the cement was not determined, but is probably quite low. The following quotation from Heath's "Manual of Lime and Cement" is interesting regarding this: "Even good Portland cement concrete, if exposed to the weather during a hot, dry summer, with no supply of moisture available, will probably be found covered with a network of innumerable hair-like cracks, which are signs of the beginning of disintegration, the natural and inevitable result of the loss of the water of hydration of the cement."

The only next briquettes which were not cracked by the heat were some very old ones, about four years old, which were tested. Most of these were uncracked, although some that were very suddenly heated cracked somewhat. All the newer briquettes cracked, the cracks being very large in most cases.

After cooling the briquettes were found to be quite soft and could easily be crushed between the fingers. This was especially noticeable in the case of those briquettes which had lost the most water of hydration. These briquettes were like lumps of dry mud or clay, and a very slight pressure was sufficient to crush them completely. Briquettes which had not lost so much water were harder, while those which had lost only about 1 or 2 per cent. of water were quite hard. Of this latter class, however, those briquettes which had been heated suddenly were much the softer.

Briquettes which were cracked on removing from the furnace showed the cracks much distended and widened out on cooling, and most of those which had not cracked in the furnace showed cracks on standing for a day or two.

All sand briquettes, whether cracked in the furnace or not, entirely disintegrated on standing in air for a time, the cementing material having been entirely destroyed. Those sand briquettes which had lost most of their water hydration disintegrated first, and those that had lost less followed soon after. Six briquettes of 2 sand to 1 cement were placed suddenly in the most intense heat, and left for about three minutes and removed. They lost from 3 to 4 per cent. in weight, and two of them, which were broken, showed a complete loss of tensile strength; one breaking before any load was applied, and the other going at about 8 pounds. The remaining four were set away, and in a couple of days commenced to crumble, the edges going first, and leaving an irregular mass in the center. This, however, resisted for some time, but in about three weeks they also were completely disintegrated.

It was thought that the sudden application of very intense heat would cause the water of hydration to be removed from the outside only, and that the inside would remain solid and resist weathering. The results, however, showed that although the outer part of the briquettes suffered most as is shown by the rapid disintegration, still the heat also affected the inner part, and caused its ultimate disintegration. These briquettes were too hot to be handled comfortably when weighed, after removal from the furnace, and it is quite probable that the heat still remaining in the outer portion caused a still further loss of water of hydration in the parts in the center of the mass. The low tensile strength of these two briquettes was probably caused by the sudden heat causing great internal stresses in the briquettes. The parts of the two broken briquettes also behaved in the same manner as the unbroken ones.

A number of briquettes were heated, and rapidly cooled by being immersed in cold water, after being heated for different lengths of time at different temperatures. In every case the briquettes cracked when immersed, and, if they were red hot before immersion, they completely disintegrated—in most cases being reduced to a heap of soft mud. The sand briquettes acted precisely similar to the neat ones, and it appears conclusive that if cement or concrete is allowed to become red-hot, and is then immersed in cold water, the effect would be ruinous in the extreme. Some briquettes were also heated, and, instead of being immersed, were placed under a small stream of water flowing at the rate of about two liters a minute. The results were the same. Red-hot cement completely disintegrated. In some cases, when heat had not been applied sufficiently long to heat the briquette through and through, and where the edges only glowed, the glowing parts chipped off when water was applied, leaving an irregular mass comprising that part of the briquette which had not been heated so much. Even when not completely disintegrated, this central mass showed cracks, was very soft, and had no strength to resist any pressure.

From these experiments, then, the following conclusions may be drawn:

1. While there is no doubt that a covering of Portland cement concrete will afford some protection to a metal column or girder, still there appears to be no doubt that the concrete itself will be ruined by the action of the fire, and will have to be removed as soon as the fire is subdued. The concrete covering may remain upon the iron work during a fire, but the heat will damage it to such an extent that it will disintegrate afterward. The impression appears to exist that the concrete will be in as good condition after a fire as before. This is a mistake, as a fire of ordinary intensity is sufficient to ruin completely a very large covering of concrete.

2. The concrete covering, if heated, will not stand the action of water; all the experiments show that water applied to hot cement is extremely ruinous. This is a very important point when we come to consider the immense amount of water thrown into a building during a conflagration. The cement is certain to become red hot, and, then, when the hose is turned on, the water strikes the protecting covering and it breaks off, leaving the iron-work bare and filling the air with a shower of dangerous falling pieces. In a fireproofed building the usual construction is to have a system of concrete arches and slabs between the joists and girders. The walls are of concrete and have metal doors to confine the fire, if started, to one spot as much as possible. The floor is usually cemented over or boarded with thin flooring, and is there-

fore more or less water tight. The ceiling, or under part, might be exposed to intense heat while immense quantities of water were being poured upon the upper portion, causing an immense strain on the concrete, not only from the weight of water, but from the opposite strains which the cement would undergo on account of one side being expanded by the intense heat, while the other side is kept cold by the water upon it. All this time the fire below is eating away the strength of the cement, and a collapse is the result.

3. In calculating for the design of the columns and girders, and especially for floors, no allowance should be made for the strength of the concrete, but the cement covering should be considered as so much extra load on the system. It is the usual custom in designing a fireproof system to consider that the concrete bears its share of the loads upon the girder, and in a great many cases the girder is designed on that assumption. If no fire occurs this is all right, but during a severe fire the concrete loses its cohesive properties, both on account of the loss of its water of hydration and on account of the great internal strains caused by the expansion of one side under heat, and consequently becomes unable to resist any stress anywhere near what it was originally able to bear, and in most cases would not even be self-supporting. The experiments have shown that sudden heating is extremely ruinous, much more so than heat gradually applied, and in the average fire a very high temperature is generated in an incredibly short time, and concrete subjected to its action would in a very short time be unable to bear any strain whatever.

It appears from this that in a fireproof building floors should never be constructed of slabs of cement forming short spans or arches from girder to girder without any support. If no load were placed on the floor and it were subjected to heat it might possibly retain its form, provided water was not thrown upon it, but if loaded, as any floor would be, a collapse is inevitable. Concrete then should always have a metal system of some sort imbedded in it sufficiently to bear the weight of the concrete itself and all external loads which may come upon it.

The great advantages possessed by cement or concrete as a fire-protecting material are its low heat-conducting power and its very small expansion under heat. These advantages, however, are entirely offset by the fact that it loses its strength under heat, is ruined by water applied during a fire, and will disintegrate after a fire, if not during the fire itself. These experiments tend to show, therefore, that the value of concrete as a fire-protecting material has been greatly overestimated and that disastrous results may follow from confidence in a building protected with such a material.

The Wilkinson Improved Gas Making System.

On August 25th U. S. Letters Patent (No. 566,363) were granted to Mr. A. W. Wilkinson, of New York, for "improvements in processes of making heating and illuminating gas." Using the words of the specification:

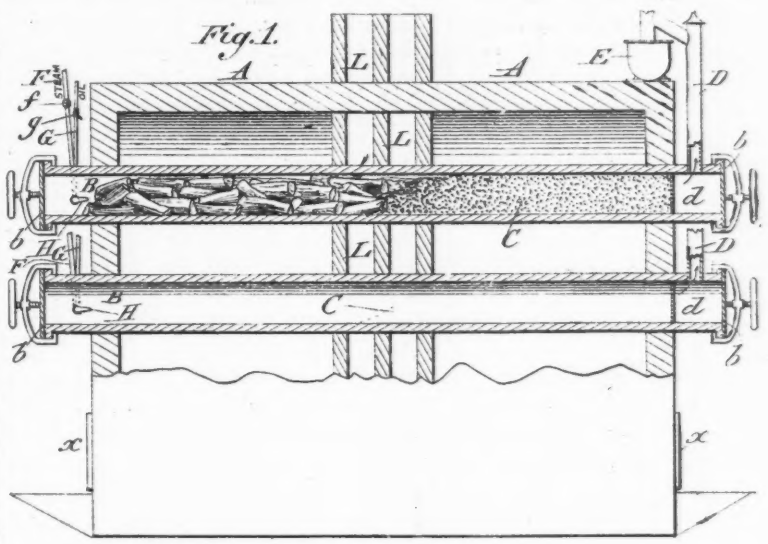
This invention relates to the manufacture of gas by the distillation of wood and the decomposition of the resulting products and steam and oil by passing the gases and vapors through a bed of incandescent carbon of a previous charge to produce a fixed gas.

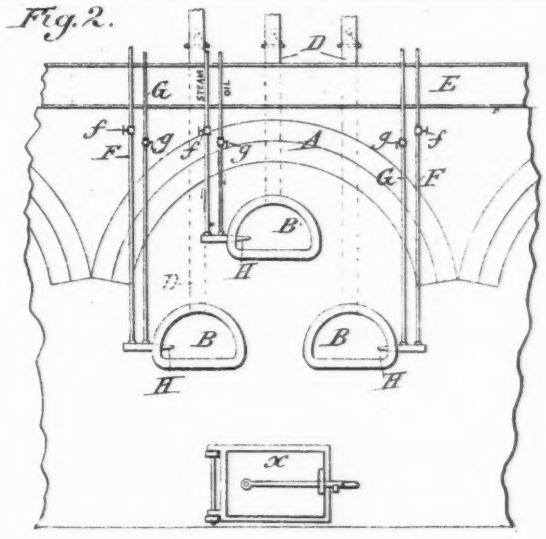
The object of my invention is to provide for thoroughly decomposing and fixing the gases and vapors generated from wood, oil and steam by first distilling a charge of wood, producing a bed of incandescent carbon, then pushing such carbon back to fill the whole cross area of one end of the retort, then distilling a fresh charge of wood and injecting oil by a jet of steam into contact with said distilling charge, and passing the whole gaseous product of the wood, oil and steam through said body of incandescent carbon, thereby making a high grade heating gas or an illuminating gas of the desired candle power.

A suitable apparatus for carrying out my process is illustrated in the accompanying drawings, in which—

Figure 1 represents a bench of through retorts, partly in elevation and partly in vertical section. Fig. 2 represents a front end view of the bench.

I preferably use through or double length retorts, so as to provide ample space at one end for a body of incandescent carbon, such as charcoal, and a space at the other end, or in the main body of the retort, for distilling a fresh charge of wood and for generating gas from oil and steam. The through retorts *B* are set in the furnace *A* in the usual manner and are closed at their opposite ends by the tight fitting lids *b*. The furnace is provided with the usual fire boxes at each end, closed by the doors *x*, and is constructed with the usual flues leading into the smokestack flues *L*, placed at the middle of the bench or setting. At one end the retorts are provided with the usual standpipes *D*, dipping into the hydraulic main *E*, and at the same end they are preferably provided with transverse perforated plates or grates *d* for sustaining the charcoal and preventing it from choking the outlets to the standpipes. An injector nozzle or pipe *H*, for oil and steam, connects with the opposite end of the retort, and with such pipe *H* there connects an oil supply pipe *G*, having a valve *g*, and a steam supply pipe *F*, having a valve *f*. The oil is preferably injected by a jet of steam through one of the well-known injectors, though the oil and steam may be admitted into the retorts through separate pipes. The retorts are heated to the proper temperature in the usual manner and are charged with wood, which is distilled until it is reduced to charcoal. When a sufficient quantity of incandescent charcoal has been formed, it is pushed back to the rear or one end of the retort, at which the standpipes connect, so as to completely fill the whole cross area at that end, as indicated by the body of charcoal *C*. A fresh charge of wood it now introduced into the retort and subjected to distillation, and the resulting products, consist





ing of gases, acids, alcohols, creosotes and tar, with steam generated from the occluded water in the wood, are caused to pass through the body of incandescent charcoal *C*, where decomposition is effected, producing hydrogen, carbureted hydrogen and carbonic oxide, with traces of other gases. When the charge of wood has been exhausted of its gases, particularly its moist gases or vapors, a suitable supply of hydrocarbon, such as petroleum or some of its distillates, or animal or vegetable oil in a fluid state, is injected by the aid of the steam jet injector into contact with the charge of distilling wood or the incandescent charcoal therefrom. The oil will undergo decomposition in contact with the hot coal or charcoal, and the resulting vapors, together with the steam or partly decomposed steam, are caused to pass through the bed *C* of incandescent carbon, where the gases are fixed and a rich illuminating gas is produced. These gases mixing with the gas produced from the charge of wood make a compound gas of from 14 to 16 candle power, depending upon the percentage of oil used. The gas, being largely composed of carbureted hydrogen, is one of the best artificial gases for heating purposes.

Some years ago the demand was for a gas having the highest illuminating power, without regard to its heating properties, but at the

present time the demand is for a gas carrying the greatest number of heat units. Gas made from wood and oil in the manner above described possesses this property to the highest extent.

As the body of incandescent carbon *C* becomes wasted away a fresh bed of incandescent charcoal is pushed back and the excess of charcoal, as formed in the retorts, is raked out in the usual manner, and a fresh charge of wood then placed in the retort and the latter tightly closed for again conducting my process of manufacturing gas.

Having described my invention, what I claim, and desire to secure by Letters Patent, is—

The process of making gas which consists in distilling a charge of wood in a closed retort and pushing back the resulting incandescent carbon to fill the cross-area of the retort, then distilling a fresh charge of wood, and passing the resulting moist vapors and gases through the incandescent carbon for effecting their decomposition, and then, by means of a steam jet, injecting hydrocarbon or other oil into contact with the partially distilled charge, and causing the gaseous products from the wood, oil and steam to pass through said body of incandescent carbon for converting the vapors into fixed gas.

Coal in India.

There is no likelihood, says *Engineering*, that India will ever be a great coal producing, or even great coal consuming country, but it is making steady progress in the direction of providing its railways and its industries with fuel from native sources. Since 1880 the amount of coal mined has been multiplied by three, and now the annual total stands at 3,167,426 tons. This is not a great amount, but it represents more than twice the total quantity burned on the railways, and has almost ousted English coal. In 1895 the locomotives consumed 145,213 tons of English coal, 1,116,481 tons of Indian coal, and 311,512 tons of wood, besides small quantities of coke and patent fuel. It will thus be seen that the railways are almost independent of British fuel, which can only compete with the home article on the seaboard, in spite of its high quality. The following table gives the comparative efficiencies of different kinds of coal, as determined by the Government of India :[1]

Description.	Equivalents.	Coefficients. Tons.
Giridih (Kurhurbaree) best steam coal	1.00	1.00
Kurhurbaree (East Indian Railway) selected large coal	0.90	1.11
Welsh best steam coal	0.80	1.25
Patent fuel	0.70	1.43
Singareni coal	1.05	0.95
Bengal or Barakar steam coal	1.10	0.90
Umaria coal	1.25	0.80
Mohpani coal	1.50	0.66
Warora coal	1.80	0.56
Wood fuel	2.50	0.40

The first coal in the list is used on the East Indian standard gauge system, and costs from 2 rupees to $2\frac{6}{16}$ rupees per ton free in truck at Giridih. Taking the rupee at 33 cents, this rate is exceedingly cheap. It is not everywhere, however, that such easy prices can be obtained. The Bengal-Nagpur Railway pays from 3 rupees 6 annas at Radhanagar to 4 rupees 12 annas, while the Indian Midland Railway system pays 4 rupees for Umaria coal in truck at the pit's mouth. These lines run in, or close to the colliery regions, and are, therefore, happily situated in respect of fuel. An example of the opposite kind is found in the Northwestern State Railway system. On the Sind-Pishin Railway patent fuel costs 27 rupees a ton at Quetta, while English coal costs 20 rupees at Kiamari. Firewood is largely used on this line, costing 45 to 60 rupees per 1,000 feet. On the east coast the long haul makes native coal dear, the price of Bengal coal at Vizagapatam varying from 9 rupees 8 annas to 13 rupees per ton. On the opposite coast English coal costs 17 rupees in boats at Bombay, while Bengal seaborne coal costs 14 rupees 14 annas.

The East Indian Railway works the collieries at Kurhurbaree and Serampore, and draws its entire supplies from them. In 1895 the total output of these pits was 442,348 tons. The Assam Railways and Trading Company work three collieries, and propose to open out a fourth. Their output for 1896 is estimated at 190,000 tons, the coal being soft and caking, with a very small amount of ash. The Government works the Warora colliery, which has six shafts, of which three are used for winding. The output in 1895 was only 101,383 tons. The Umaria is another Government colliery, furnishing 118,500 tons last year. One of the largest mines in the country is the Singareni colliery of the Hyderabad Company, Limited. Its output last year was 293,000 tons, which is to be largely increased. Two new pits are being sunk, and are to be provided with winding, hauling and screening machinery for an output of 1,000 tons a day each. The Dandot colliery, worked in connection with the Northwestern State Railway, is comparatively a small affair; it raised 46,171 tons last year. Another colliery—much smaller—pertaining to the same railway, is the Bhaganwala, from which 6,137 tons were extracted last year. The coal has to be transported long distances on pack animals, which accounts for the small production. Two other small mines under the same management are the Khost and the Sharigh. A new mine has been found near Mach, which it is hoped may serve the Bolan, as the Khost has served the Sind Pishin line. The Khost and Sharigh pits are in the Harnái Valley, near Gundak, north of Quetta, in Baluchistan. There are some other small pits in the same neighborhood, but the coal is poor in quality and the seams thin.

1. Administration Report of the Railways of India for 1895-6, by Colonel T. Gracey, R.E., Director-General of Railways.

The collier seems to be fond of holidays all the world over, for we find references to "pay Monday" and "feast days" in connection with the Indian mines. No doubt the darkness and solitude give rise to a craving for change and excitement both in the Hindoo and in the Anglo-Saxon. The safety of the various mines we have referred to seems to vary very greatly, the quantity of coal raised per death being as little as 3,131 tons at the Sharigh colliery, against 147,500 tons at the Kurhurbaree mine. The weight of coal raised per person employed is small, varying from 7 tons at Bhaganwala to 137 tons at Umaria.

The hopes once entertained of raising petroleum in large quantities in Assam and in northwestern India have not been fully realized. Ten wells have been drilled at the Makum Oil Concession without any workable quantity of oil being found. At the Dighoi field 13 holes have been put down from 662 feet to 1,225 feet, but only 36,435 gallons of crude oil were extracted in the year. The Khattan borings have been abandoned, and a borehole has been put down 1,500 feet at Sukkur without finding oil.

The Decomposition of Hexane by Heat.

The *Gas World* gives the following resume of a series of articles on this subject, which were originally prepared for the German *Journal of Gas Lighting* by Messrs. F. Haber and H. Samoylowicz:

Complete analytical investigations have been lacking in respect to the fatty series; benzol has been worked out by Berthelot, who has not been as successful with the fatty series. Berthelot's main conclusions are (1866-1879): (1) that the decomposition of a hydrocarbon does not correspond to its resolution into elements but to the formation of polymers or more condensed hydrocarbons with elimination of hydrogen; (2) that the processes of decomposition and recomposition come to balance one another; (3) that hydrogen is both torn off and added on to the hydrocarbon molecules; (4) temperature and time are so related that an excess in the one may make up for a defect in the other. He assumes, arbitrarily, that the processes in a retort and in a tube are the same; which may be correct if the products of decomposition are kept for a long time in the tube, but not otherwise. The primary products of decomposition are the important things to inquire into, not the products of secondary reactions. It is quite true that as the temperature rises the tar becomes more and more carbonaceous and yet does not cease to contain hydrogen; but it is not clear that there is any continuous polymerisation such as that described by Berthelot. Neither is his alleged equilibrium proved; and it is in itself improbable, for acetylene produced does not remain within the fatty series, to stand in equilibrium within it.

Professor V. B. Lewes seems to have been influenced by Berthelot's conclusions, and he attributes to acetylene an even more important part than Berthelot had assigned to it; but he is at variance with Berthelot in finding that acetylene also deposits carbon, not by successive polymerisation, but by a direct break-up into carbon and hydrogen. Lewes is not, any more than Berthelot, in a position to show that acetylene is produced in quantities corresponding to his equations, and he has to assume that it is directly transformed into tar and carbon. He relies upon acetylene to the exclusion of the separation of carbon from heavy condensed hydrocarbon molecules, which is surely a mistake, for tarry compounds must be produced in the flame, and are deposited on a cold plate, and even in the luminous part of the flame the soot is not free from hydrogen. Nothing is gained by assuming that acetylene is formed and instantly broken up; the heat absorbed is at once given out prematurely. But, speaking generally, Lewes' experiments are valuable ones as to the decomposition of hydrocarbons by heat.

Whatever may be the case with the lowest members of the series,

Berthelot's results cannot be generalized so as to make them apply to higher members, such as hexane, C_6H_{14}, or trimethylethylene $C_2(CH_3)_3H=C_5H_{10}$. In the higher members we may suppose decomposition to take place on the lines of the equation $C_6H_{14}=C_5H_{10}+CH_4$; whereas in the lower we can only suppose hydrogen to be taken off. Again, hexane very readily decomposes at low temperatures, whereas methane and ethane will only decompose at high temperatures; so that methane and ethane are only apparently the simplest substances on which to experiment. Hexane ought also readily to form benzol, and, besides, it is of practical interest as forming the main constituent of gasoline.

The result of experiments on hexane is not that hydrogen is split off, but that the molecule breaks up into smaller molecules. It is easier to separate carbon from carbon in the carbon chain than it is to pull the hydrogens off the carbons. In the aromatic series the reverse is the case. Breitenlohner showed, in 1863 and 1865, that if only 8 per cent. of gas were cracked up he obtained marsh gas, ethylene, hydrogen, carbonic oxide and acetylene, but gave no numerical data. Vohl showed, in 1865, on the other hand, that if heavy vapors from American petroleum were broken up by overheating, there was no hydrogen unless the temperature was very high and the rate of flow of gas very small. Thorpe and Young, and Engler and his pupils, have got similar results with paraffine and with brown coal oils.

The smaller molecules are themselves acted upon by continued heat, so that in order to obtain the reaction $C_6H_{14}=CH_4+C_5H_{10}$ the vapor of hexane must be exposed to a temperature of from 600° C. to 800° C. for not more than, say, two seconds. Hydrogen is then neither liberated nor added to the unsaturated molecule. With trimethylethylene the unsaturated molecules more obviously tend to coalesce and form polymers; and this is the true nature of the pyrogenic process, not an equilibrium between composition and decomposition, for the building up takes a different course, and forms products other than those which are being pulled down.

Between 900° C. and 1,000° C. this simplicity disappears; the primary products are no longer stable, and secondary reactions come into prominence. The polymers, produced by coalescence of the unsaturated molecules, themselves split up and become tarry, with separation of hydrogen, as in Berthelot's and Lewes' special case, and there is no longer any precise law statable. The gas produced contains hydrogen, marsh gas, ethylene, benzol, and only traces of other hydrocarbons. The gases produced at lower temperatures contain hydrocarbons which have been taken for homologues of methane, and therefore of the paraffine series, but which appear to be really poorer in hydrogen, and to be probably trimethylene compounds.

Hexane does not appear to have any special tendency to form benzol; it produces the same quantity as trimethyl ethylene does; whence it would appear that the benzol formed is itself merely a secondary product, very probably from acetylene. The enriching value of gasoline, treated at a low red heat, is mainly due to heavier olefines, not to benzol; and these may roughly be taken as equivalent to equal weights of ethylene. But between 900° and 1,000° the enrichment is due to benzol frequently quite as much as to the ethylene, which is then the only olefine formed, and in some cases (*e. g.*, in the decomposition of trimethylethylene) even more so. At higher temperatures than this the yield in benzol is itself diminished.

Such are the main results of the experiments, full details of which, both as to apparatus, methods and numerical data, will be found in the numbers of the *Journal für Gasbeleuchtung* above referred to; but Dr. Haber notes that with hexane treated at 700° to 800° C. an oil gas is produced which, after cooling to 14° F., and washing, not with water, but with 0° paraffine, gives 61½ to 74½ English candles per 5 cubic feet and 85 to 90 candle hours per pound of material used; and the "tar" contains from 37 to 48 per cent. of amylene and unaltered hexane. He concludes that hexane has not hitherto had justice done to it as a means of producing oil gas, for hitherto only some 30 per cent. of olefines have been formed, instead of 50 per cent. as now obtained by merely momentary heating of the vapor of the hexane employed.

Experiments with a Differential Wattmeter.

[By Mr. A. B. Reynders, in the *Scientific Magazine*, of the University of Tennessee.]

The losses in a transformer are of importance, though, up to the present, difficult of measurement.

There are seven distinct methods more or less well known and practiced, namely: The calorimeter, dynamometer, three voltmeter, three ammeter, three transformer, wattmeter and the method of using E.M.F. and current curves. All of the above methods have objections, involving either very accurate readings to obtain fairly accurate results, or else expensive and delicate apparatus. The wattmeter method is the one most used at present, and after the application of a correction for self-induction the results are taken as accurate.

A little over a year ago the idea was suggested of making a differential wattmeter, that is, two wattmeters having their suspended coils rigidly connected together, and acted upon differentially by the fixed coils. Such an instrument was constructed at that time. The fixed coils were arranged one pair above the other and in the same vertical plane, the distance between the upper and the lower pair being small. The primary current (in this case of low voltage) was passed through the upper fixed coils, while the suspended coil was in shunt with the primary of the transformer to be measured. In the same manner the lower fixed coils were in series with the secondary, while its suspended coil was in shunt with the load. The current was so sent through the coils that the upper pair tended to throw the suspended coil in one direction, while the lower pair tended to throw its suspended coil in the opposite direction. These two suspended coils being rigidly connected together yet insulated from each other, had as a whole very little deflection, and by the proper adjustment of resistances in series with them this deflection may be made zero. A mirror was attached to the suspended coils, and, by means of a telescope and scale, the least motion could be observed.

The actual method of using the differential wattmeter consists in first adjusting the deflection to zero, then calibrating by using a continuous current. By the use of a formula which will soon be deduced we are enabled to find the efficiencies by observing only the various resistances. The adjustment to zero is first accomplished partly by sliding the fixed coils in or out so that there is little deflection, and then reducing this deflection to zero by varying the resistances in series with the suspended coils. After this has been done, and without changing the position of the fixed coils, the instrument is calibrated by using a continuous current, passing the same current through both fixed coils connected in series, and adjusting the deflection to zero by varying only the resistances in series with the suspended coils.

The formula above referred to is found as follows:

Let I_1 = alt. current in fixed primary coils.
i_1 = " " " suspended primary coil.
I_2 = " " " fixed secondary coils.
i_2 = " " " suspended secondary coil.
I_1^1 = continuous current in fixed primary coils.
i_1^1 = " " " suspended primary coil.
I_2^1 = " " " fixed secondary coils.
i_2^1 = " " " suspended secondary coil.

K_1, K_2 = constants of the primary and secondary wattmeters respectively.

R_1, R_2 = resistance in primary and secondary suspended coils with alternating current.

R_1^1, R_2^1 = resistance in primary and secondary coils with continuous current.

d_1, d_2, d_1^1, d_2^1 = deflection of primary and secondary coils for alternating and continuous current respectively.

For alternating currents:

$$d_1 = K_1 I_1 i_1 = K_1 I_1 \frac{E_1}{R_1}$$

$$d_2 = K_2 I_2 i_2 = K_2 I_2 \frac{E_2}{R_2}$$

Making the deflection equal to each other or the deflection of the coils differentially connected, zero.

$$K_1 I_1 \frac{E_1}{R_1} = K_2 I_2 \frac{E_2}{R_2}$$

$$\frac{K_1}{K_2} = \frac{E_2 I_2 R_1}{E_1 I_1 R_2} \quad \ldots\ldots \quad \ldots\ldots (1)$$

For continuous currents:

$$d_1^1 = K_1 I_1^1 i_1^1 = K_1 I_1^1 \frac{E_1^1}{R_1^1}$$

$$d_2^1 = K_2 I_2^1 i_2^1 = K_2 I_2^1 \frac{E_2^1}{R_2^1}$$

Making $d_1 = d_2$ for same reason as given above, and using the same current in both the fixed pair of coils and the same difference of potential at the ends at the suspended coils.

$$K_1 I_1' \frac{E_1'}{R_1'} = K_2 I_2' \frac{E_2'}{R_2'}$$

$$\frac{K_1}{K_2} = \frac{R_1'}{R_2} \quad \ldots\ldots\ldots\ldots (2)$$

$$\text{Whence} \frac{R_1'}{R_2'} = \frac{I_2 E_2 R_1}{I_1 E_1 R_2} \text{ by sub. (2) in (1)}$$

$$\text{Efficiency} = \frac{I_2 E_2}{I_1 E_1} = \frac{R_2 R_1'}{R_1 R_2'}$$

which is a very easy expression to handle.

The instrument as constructed last year was very unreliable, having nothing to recommend it but its desire to make all transformers have an efficiency greater than unity. The induction of the upper coils on the lower ones and *vice versa*, or, more likely, the direct action of the lower fixed coils on the upper suspended, and *vice versa*, caused a very serious error in the results.

About this time a differential wattmeter, constructed by Prof. Kennelly,[1] came to our notice, and information was immediately sought about his instrument, with the result that we found several sources of error present in the wattmeter which up until then was thought to be original.

Taking advantage of Prof. Kennelly's suggestions, the fixed coils were separated about 8 inches and placed at right angles to each other in a new differential wattmeter constructed at the beginning of this year. On testing the instrument for cross induction by passing a current through the fixed coils while the suspended coils were short circuited, no deflection was observed. The instrument was then tried to determine the efficiency of a transformer built in the shops for a capacity of 10 lights, but slightly damaged in some experiments. The transformer was designed to work on an alternating circuit of 20 cycles per second, being used as a step up, having 10 lights in series on the secondary. The high voltage of the secondary required a high resistance in series with its suspended coil.

At first great difficulty was experienced in obtaining a suitable resistance, and after many substitutes were tried resort had to be made to wire resistances. These resistances were in part constructed in the shops of the University and in part consisted of an ordinary 100,000 ohm box resistance. The coil constructed in the shop was wound non-inductively on a wooden frame 12 inches high, 8 inches long, 6 inches wide, and measured about 42,000 ohms. The resistance box had 10, 20, 30 and 40,000 ohm coils, each wound non inductively on a single spool.[2]

In using the instrument with these high resistance coils in series with the secondary suspended coil, fairly consistent results were obtained with the 20-cycle machine, as can be seen from a set of experiments given below:

No. of Exp.	R_1	R_2	$R_1{}^1$	$R_2{}^1$	Eff.	Volt of Prim.	Load in Lamps on Sec.
13	8,370	132,439	6,030	142,454	67.0	65	14
14	6,360	102,272	6,030	142,454	68.0	65	14
15	6,120	102,272	6,030	142,454	70 7	65	10
16	6,360	102,272	6,030	142,454	68.0	65	12
17	6,640	112,352	6,030	142,454	70.6	65	14

All of the above results were very easily and quickly obtained. Some irregularities were introduced by sparking of the commutator, which finally became so great that these experiments had to be discontinued.

The instrument was next tried on a transformer, using a current of 60 cycles per second, and efficiencies ranging from 83.8 per cent. to 109 per cent. were obtained. Below is given a table which one can see at a glance is totally unreliable.

No. Exp.	Load.	Eff.
25	(Twenty lights) full load	106.4
26	Half load	101.2
27	Half load	102.8
28	One-fourth load	109.4
29	One-fourth load	107.0
31	Full load	104.0

It will be noticed that no two measurements on same load agree, but differ about 2 per cent.

Attention has been called by a number of experimenters to the error that may be introduced by the capacity of resistance coils, and the differences above given have been, largely at least, traced to this cause.

1. *Electrical Engineer*, Dec. 21, 1892.

2. As this coil was damaged and repaired, without adjusting, early in the experiments, these values are only approximate. The exact values are of course employed in reducing the results.

To determine this source of error an electro-dynamometer was specially constructed and placed in series with the resistances. First the 60-cycle current was sent through the circuit and the deflections noted, and then a continuous current, produced by about the same E.M.F. was used, noting the corresponding deflections. The square root of the deflection divided by the voltage[1] should be the same in both cases if there were no capacity. This was not the case, as can be seen from the following table:

Resistance.	Alt. Current Sq. Rt. of Deflection Divided by Voltage.	Cont. Current Sq. Rt. of Deflection Divided by Voltage.	Pr. Ct. of Alt. Current Resistance above Cont.
132,439	.025	.020	45 per cent.
112,394	.028	.028	0 "
42,110	.061	.055	11 "
40,182	.060	.044	36 "

The decided differences found in the different experiments correspond with differences in the resistance coils used. In the first and fourth, the 40,000-ohm coil in the resistance box was used. This spool, being compactly wound, had a much greater capacity effect than the similar resistance used in the third experiment, which was wound upon a wooden frame.

No such differences were observed when using the low period current (20 cycles).

Experiments with the differential wattmeter have been carried only to this point, but they are sufficient to show the need of special examination of the coils of wattmeters before they can be used for alternate current measurements, and are sufficient to cast more or less suspicion of inaccuracy upon all wattmeter measurements.

It is also evident that all potentiometer, or other zero methods, as applied to alternate current work, have only a fictitious accuracy. For the strength of the current passing through any coil of wire with a given electromotive force must be determined by direct measurement by means of an electro dynamometer instead of depending upon resistance comparisons by Wheatstone's bridge.

That such errors have not been more conspicuous in the past is no doubt due to the lower resistances usually employed in such work, but there is no doubt of the possibility of such errors in many of the alternate current voltmeters and wattmeters now employed.

The Insurance of Electrical Plants.

In a paper on this topic, read by Mr. R. H. Pierce before the Northwestern Electrical Association, the author said:

One of the most serious problems to the owner or manager of a central station is the reducing of the fire hazard to a minimum. The problem of safety is the real question, and when this is solved we at the same time solve the problem of insurance.

In the opinion of the writer, the insurance question which the central station manager has to answer is simply the question of making his plant insurable. This may appear to be a radical view, but I believe it is logical. A large proportion of existing plants were installed at a time when the electrical manufacturers and electrical constructors did not understand what materials and methods should be used in order to secure safety; and finally, and worst of all, many plants have been installed by companies or individuals whose only thought was to get the largest price for the cheapest installation, leaving the unfortunate station owners and managers to wrestle with the question of safety, as well as of reliability and economy. But however serious the question may be, it must be met and if attacked in the right way, the solution may not be as difficult as it at first appears.

The results of a central station fire are twofold: First, there are the losses due to interruption of service; and second, there is the loss of plant. I have placed the losses due to interruption of service first, as these must be considered whether we consider the question of insurance or not. The interruption of service for any considerable time, or a decrease in patronage due to irregular or uncertain service may, and often does, mean a difference in revenue, which is the difference between a profit and a loss in the operation of the station, and operating a station at a loss is worse than losing it.

The way to secure safety and reliability is to have proper construction and proper care, protection and attendance. The proper methods for securing safety are laid down in the rules and requirements of the National Board of Fire Underwriters and are well known to all engineers and constructors of any standing.

The question of insurance can be met in three ways: First, by insuring in responsible and reliable insurance companies; second, by the

1. Measured by an electrostatic voltmeter.

formation of a mutual company by central station owners; third, by securing the maximum safety through the use of proper construction, care and fire protection, and taking the chances of a fire loss.

As a general proposition the only reasonable course is the first one indicated, namely, the insuring in responsible and reliable companies. The plan of forming a Central Station Owners' Mutual has been "weighed in the balance and found wanting." Theoretically, it may be possible to form such a mutual company, but it would be an additional burden to the central station business, which, I take it, has trouble and problems enough to face already. If fire insurance is a legitimate business—and it appears to be as legitimate a business as electric lighting—then we may as well assume that the insurance people know their business and that the competition between insurance companies will produce as low a rate as could (with equal protection) be given by a mutual company. The third method mentioned, of securing maximum safety and then taking the chances, may be the best in some, but only in very special cases. If the central station plant is so designed, installed and operated as to reduce the fire hazard to a minimum, insurance companies will ask a minimum rate of insurance which, in most cases, will be so small as to be no burden to the owners. Discarding then the two plans just mentioned, we are brought to the first plan of insurance in reliable companies. Accepting this as our line of action, the problem now is to so install and operate our plants that the hazard is reduced to a minimum or at least to a point where further improvements would increase the cost out of proportion to the additional safety secured.

The great problem is, as I have said, how to best secure safety. Competition in the electrical manufacturing and construction business has not led to increased safety. On the contrary, it has led to cheapness in both appliances and methods, and cheapness does not mean safety. On the other hand, we must not think that we must be extravagant in order to have safety. The use of proper methods of construction and of intelligence and care in operation is what is most necessary to secure safety.

If, however, we cannot look to the electrical companies for protection, to whom shall we look? Who should judge of what is necessary for safety? Who has devoted most time and thought to this subject? The National Board of Fire Underwriters beyond a doubt. Whether we insure or not, the regulations of the underwriters are to day the best, and we may say, only guide to safety. Their requirements can of course be improved, but the insurance people are ready and anxious to receive suggestions from all engineers and central station men. I sincerely believe that a study of the requirements of the underwriters, and a free discussion of their merits by central station men and engineers, is the one thing that will lead to an understanding of the insurance question and will eventually lead to an understanding between owners and insurance companies, which will be mutually satisfactory.

Every one of the underwriters' rules represents thought, investigation and experience.

The base rate of the rate of insurance for central stations which conform in all respects to the requirements of the underwriters is 50 cents per $100. For every point in which a station fails to conform to the requirements, a certain addition is made to the rate.

The underwriters recognise 34 specific causes for raising the rate above the base or minimum amount. These causes are violations of the rules and regulations, and do not consider "external fire protection," "other occupancy," "condition," or "exposure." A specific addition is made to the rate for inadequate fire protection, and an addition is made for other occupancy, condition, exposure, according to hazard. The 34 causes just mentioned are all violations of the regulations concerning construction of buildings, electrical arrangements, or care and attendance, and are therefore all causes within the control of the owner.

These 34 causes may, if they all exist, raise the rate to over $10 per $100, but of this sum, over $5, or more than half the amount, is due to the following causes: Improper arrangement of stack, defective wiring, improper construction of switchboard, improper construction and placing of rheostats, storage of oils, gasoline, etc., in station, and improper storage of ashes. All of these are defects that should and always can be avoided, and usually at small expense.

THE County Commissioners of Baltimore county, Md., have contracted with the Edison Electric Illuminating Company, of Baltimore, for the lighting of certain named streets, highways and lanes of Baltimore county for a period of 5 years. The contract specifies that each arc lamp maintained shall have an illuminating value of 2,000 candles; that the lamps shall be kept alight each night and all night; and that the rate of payment for each arc shall be 35 cents per night.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

THE proprietors of the Atlantic City (N. J.) Gas Light Company are adding to the capacity of their plant by the installation of water gas apparatus of the standard double superheater type of Lowe construction, as built by the United Gas Improvement Company. The new works will have a capacity of 500,000 cubic feet.

MESSRS. W. G. and G. Greenfield, proprietors of the Greenfield Engine Works, of East Newark, N. J., report a very satisfactory condition of trade just now. A noteworthy transaction recently completed by them was the shipment of two metal presses to Germany.

SOME time ago the Richmond (Va.) Common Council appointed a "Committee on Retrenchment and Reform," the members of which were instructed to report as soon as possible any "retrenchments" that could be made in the matter of economies regarding the operating of any of the city departments. On the 8th inst. the "retrenchments" were reported, and on the list we find the following recommendations respecting the gas works department: "To dispense with the horse and buggy of the Superintendent of the gas works; to reduce the salary of the Superintendent of the gas works to $2,750 per annum; to reduce the salary of the Chief Inspector to $1,200; to reduce the salary of the foreman of the upper gas works to $1,200." There are other "retrenchment" hints in the report, but we believe those noted are sufficient to show the wretchedness of the suggested lines of "reform."

MR. J. W. MADDOX has resigned the position of Superintendent of the Austin (Tex.) Water, Light and Power plant. This plant is operated on municipal account.

MESSRS. JAMES F. ESHELMAN, David L. Haymaker, Daniel F. Haymaker, M. M. Pfantzy and A. L. Thomas have incorporated the American Gas Regulation Company. The concern proposes to operate in Seattle, Wash.

MR. T. S. C. LOWE, President of the Passadena (Cal.) Consolidated Gas Company, in notifying the residents of some proposed betterments on the Company's plant, says: "The rapid growth of the city of Passadena has made it necessary to prepare for large extensions of gas mains to accommodate the hundreds of applicants for gas for heating, cooking, lighting and other purposes, and in answer to this call the Passadena Consolidated Gas Company has created bonds for the purpose of not only enlarging its works, which is now under contract, but to lay at least 10 additional miles of street mains during the coming autumn and winter. It is now fully conceded over the entire civilized world that the Welsbach burner produces the best, most ornamental and cheapest light of all other methods of illuminating, and especially so with the excellent quality of gas supplied by this Company, which also applies with equal force for heating, cooking and power purposes. As a solid, safe, sure and best-paying investment, gas securities stand at the head of all others. It is the only investment that has never sustained a shrinkage nor disappointed its investors. Its value is continually on the increase in all parts of the world, caused by the many uses to which gas is being continually applied. Passadena is no exception to this rule, but on the other hand increases faster in value on account of the almost universal use of gas for cooking purposes. The Company's policy also of reducing the price of gas has met with corresponding increase of business, and it is expected that the business gained by the proposed extensions will enable the Company still further to reduce the cost to consumers, which, at the present rates, taking quality into account, is the cheapest gas on the Pacific Coast, and is now one-third less than the average cost throughout the State."

THE Pittsburgh (Pa.) *Telegraph*, of the 10th inst., said: "The Acetylene Light, Heat and Power Company, which was going to revolutionize things a year ago, held its annual meeting this week in Philadelphia. After the meeting the stock ($30 paid) declined to 7¾, the lowest recorded offer." Comment is unnecessary.

THE reconstruction of the Fort Madison (Ia.) plant is going ahead satisfactorily.

"SOME time ago," says a correspondent, "the Lamp Committee of the Meriden (Conn.) Council held a meeting to consider the proposition submitted by the Meriden Gas Light Company for lighting the streets with electric lights of 1,200-candle power. The figure proposed by the Company for each 1,200-candle power arc was $97.50, on the basis of a 3-year contract. The Company had already proposed to furnish arcs

of 2,000-candle power for $109 per year each, on a 3-year contract, and for $112 each on a 1-year contract. After considering the first mentioned proposition the Committee decided that the 1,200 candle power lamp would be impracticable and it was determined to leave that out of future consideration. The candle power of the lamps (2,000) will not be changed, and the Committee decided to ask the Council to empower it to make a contract with the Company. The nature of the contract the Committee does not desire to make public until it can report to the Council. The length of the contract is the main point to be determined, and it is rather believed that the period favored by the Committee is the short term one."

WE understand that 910 shares out of the 1,600 shares of the capital stock of the Wallingford (Conn.) Gas Light Company have been put on the market, "for sale at a reasonable price." The par value of the shares is $25.

THE Reading (Mass.) *Chronicle* of recent date had this to say: "At 3:30 o'clock, Wednesday afternoon, Sept. 30th, Auctioneer George Horrocks will sell at auction all the property in Reading owned by the Citizens Gas Light Company of Reading, South Reading and Stoneham, unless a settlement is previously effected. The sale is to satisfy a mortgage held by W. B. Littlefield. Some year or more ago a committee of the town of Reading tried to ascertain at what price the property involved could be purchased by the town, and, if we are not mistaken, the Company's representatives were reluctant to name a price, because the committee did not have authority to purchase. However, an idea was arrived at that about $10,000 would be required, and some citizens were in favor of purchasing at that price. It would seem that now an excellent opportunity is offered to acquire the property at a song, and it would be an eminently wise move for the town to have representatives at the auction authorized to buy if the bidding does not go beyond a certain limit. The matter seems to be of sufficient import for the calling of a special town meeting.

IT is reported that the proprietors of the Pawtucket (R. I.) Gas Company are seriously considering the matter of engaging in the manufacture of ice.

THE Chelsea (Mass.) Gas Light Company will construct a commodious coal storage shed at Spruce and Auburn streets. The ground dimension is to be 60 feet by 120 feet.

MR. EDWARD C. LEE, Treasurer of the Fall River (Mass.) Gas Works Company, has caused the following advertisement to be printed in certain newspapers of Massachusetts: "In accordance with Acts of 1894, Chapter 472, and the order of the Board of Gas and Electric Light Commissioners of Massachusetts, will be sold at auction to the highest bidder, at not less than par, by R. L. Day & Co., at the Real Estate Exchange, No. 7 Exchange Place, in the city of Boston, Mass., on Saturday, September 26th, 1896, at 11:30 o'clock, A.M., 1,595 shares of the new capital stock of the Fall River Gas Works Company, being the same unsubscribed for by the stockholders. Terms of payment: 10 per cent. at time of auction sale, 15 per cent. on or before November 1, 1896, 25 per cent. on or before December 1, 1896, 25 per cent. on or before January 1, 1897, and 25 per cent. on or before March 1, 1897.

ON the 11th inst. the Kansas City (Mo.) Gas Company paid over to the City Comptroller the sum of $2,294.05, which sum represented 2 per cent. on the gross receipts of the Gas Company for the six months ended August 31st.

THE Chattanooga (Tenn.) Gas Light Company has been appointed selling agent for the Welsbach lamp in that city.

THE Bristol County Gas and Electric Company has petitioned the Council of Warren, R. I., for the exclusive right, for a period of 25 years, to maintain poles, wires, etc., over and under the streets and highways of the town, in accordance with the provisions of Chapter 77 of the general laws, for 1 per cent. of the gross earnings of the corporation.

MR. JAMES GAMBLE, of this city, has been elected President of the Rome (N. Y.) Gas Light Company, vice Mr. T. H. Stryker, resigned.

THE Washington (D. C.) Gas Light Company has arranged for the construction of a brick building at 29th and G streets, which structure is intended to cover a notable addition to the Company's purifying plant.

THE proprietors of the Faribault (Minn.) Consolidated Gas and Electric Company have authorized the United Gas Improvement Company to construct for them a water gas setting of the Improvement Company's standard Lowe type. The method of making gas (distilling oil in retorts) heretofore followed at Faribault will be abandoned.

POUGHKEEPSIE (N. Y.) has an association which is known to fame locally as the "Retail Merchants Association," and its doings so far have been of the order meddlesome. At a recent "regular" meeting the "Retailers" considered the subject of the price charged for gas by the Poughkeepsie Gas Company, and the outcome of the debate was the appointment of a committee charged with the task of securing a reduction in the gas rates. We imagine the committee will have a hard time of it in achieving success on the lines proposed; for the average rate obtained by the Poughkeepsie Gas Company per 1,000 cubic feet does not exceed $1.35. This, too, for a gas that averages 24 candle power.

THE proprietors of the Duluth (Minn.) Gas and Water Company have offered all their interests in that corporation to the authorities of Duluth. The sum named as the selling price, to all intents and purposes, is $1,695,000.

ON the other hand, the city has been anxious for some time to acquire possession of the above-named properties, particularly the water division thereof, offers the Company $1,114,356.

WE are gravely informed by the Pottstown (Pa.) *Ledger* that a resident thereof, by name Jacob Van Norman, has secured letters patent for an air gas system that is to supersede all other illuminating gases in use at the present time. It costs to manufacture only 3 cents per 1,000; and the "process of manufacture is very simple, in that it is accomplished by bringing air in contact with a specially prepared chemical compound." Mr. Van Norman also "points with pride" to the fact that as his "air gas contains 86 per cent. of pure air, it can be inhaled with impunity;" further, that "such air content precludes all danger from explosion, etc." Just so.

THE contract between the authorities of Le Roy, N. Y., and the Le Roy Gas Light Company for the public lighting of that place expires October 1st. Under the existing plan a moontable is followed, but it is more than likely that the next contract will be based on an all and every night service.

THE plant of the New Castle (Del.) Company, which was acquired some time ago by Mr. J. E. Addicks, is to be changed to manufacture water gas.

THE following is from the Omaha (Neb.) *Bee* of the 11th inst.: "An ordinance which proposes to grant a franchise to the Nebraska Gas Company, which was drawn up by Councilman Wheeler, as Chairman of the Committee on Gas and Electric Lights, and introduced at the Council meeting Wednesday night, differs very materially from any similar ordinance that has ever been considered by the City Council. It is very strict in its provisions, and if the Company accepts the franchises which it proposes to offer it will do so under restrictions that are said to protect the interests of the city. The claim of members of the Committee is that the city has learned several lessons by reason of its connection with previous franchises asked for. * * * The new ordinance which is recommended by the Committee limits the life of the franchise to 25 years. It must be accepted within 30 days from the date of the passage of the ordinance, and the Company must deposit with the City Treasurer $50,000 in cash or municipal bonds as a guarantee of good faith, to remain on deposit until the plant is completed. This feature is taken from the Kansas City ordinance. The Company is also required to deposit $5,000 as a guarantee that all streets that are torn up for the purpose of laying mains will be replaced in as good condition as before. When the plant is completed $4,000 of this amount will be returned, and the remainder retained by the city. This ordinance provides that the Company shall build a plant which will be equal in capacity, equipment and value to the plant at Kansas City. It must invest $600,000, exclusive of the value of real estate, in the two years following the acceptance of the franchise. It is also provided that the location of the proposed plant shall be approved by the Mayor and Council. The Company is required to lay at least 50 miles of mains, and another provision requires it to parallel all the mains of the old Company or of any other Company that may be organized within three years. On paved streets it must lay a main on each side of the street, in order that the center of the street will not be cut up to make lot connections. The royalty to be paid by the Company is fixed at 5 cents per 1,000 cubic feet of gas sold. It must make all lot connections inside of

(*Continued on page* 455.)

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(*Continued from page* 454.)

the property line. The new Company is prohibited from entering into any pool or combination with any other Company, and from assigning its franchise to any other individual or corporation. It is prohibited from bonding or mortgaging the plant for more than two-thirds of the actual capital invested, and no bonds or mortgages can be executed without the consent and approval of the Mayor and Council. The price to be charged to consumers is fixed at $1 per 1,000 cubic feet, and it is also provided that when any device for cheapening the manufacture of gas is introduced in other cities the Omaha Company shall adopt it and reduce its prices in proportion. The price for street lights is fixed at $18 per lamp, or $12 per lamp for a moonlight service."

MR. BENAWA, of the Omaha (Neb.) City Council, has introduced a resolution which proposes to repeal three gas franchises that have been granted by the city, but which have not been availed of by their accepters. Taking the grants in the order of their issuance, the first was passed (in 1883) to the United Gas Improvement Company; the second (1887), to the Kansas Gas and Heating Company; the third (1888), to Casper E. Yost and E. M. Morsman.

AT the annual meeting of the shareholders of the Oroville (Cal.) Gas, Electric Light and Power Company, the following officers were elected: Directors, J. C. Osgood, R. S. Powers, C. W. Putnam; Max Marks, F. H. Gray and J. Karnsner; President, J. C. Osgood; Vice President, R. S. Powers; Secretary, C. W. Putnam; Treasurer, Bank of Oroville; Superintendent, James Havey.

AT a meeting of the Technical Society of the Pacific Coast, held the first week in September, the feature of the session was a lecture, by Mr. Edward C. Jones, of the San Francisco Gas Light Company, on the Roentgen rays. The lecture was illustrated in practical manner by the taking and development of a radiograph of an injured arm, the patient being young Frank Cunningham, a student at the Sherman Grammar School. The radiograph showed that a small bit had been broken off the injured lad's "funny bone," during some horse play that he had indulged in at school the previous day.

Coal in Ohio.

Mr. R. M. Haseltine, the Chief Inspector of Mines of Ohio, gives the year's production of coal as 13,683,879 tons, an increase over the preceding year of 1,773,660 tons. The increase in lump coal is 1,349,231 tons; in nut coal, 113,755, and in pea and slack, 316,674 tons. The unusual percentage of gain in lump coal is ascribed to the increased use of mining machines and the adoption of improved methods in mining. In point of production the four leading counties are: Jackson, 2,072,939 tons; Perry, 1,789,109 tons; Athens, 1,435,744 tons; Hocking, 1,432,741 tons. The counties of Athens, Hocking and Perry, which compose the Hocking Valley coal field, produced 4,657,594 tons, an increase over the year 1894 of 285,793 tons, a percentage of the whole output of the State of 34 per cent. This is a decrease of 2.1 as compared with the preceding year, of 3.7 as compared with 1893, and of 4.4 during 1892.

Of the year's production 3,120,456 tons were mined by machinery, an increase of 564,990 tons as compared with 1894. This output is the greatest in the State's history and the gain has been exceeded but once since a record has been kept of the product arising from this source. The greatest production was in Hocking, which is given at 1,302,398 tons, followed by Athens with 838,708 tons and Perry, which is given at 768,779 tons.

The average time worked is given as 156 days, as against 132 days during the preceding year. Four hundred and forty-seven hands were employed in operating the machines and 3,374 hands in blasting down and loading the coal after it had been undermined by the machines. Installations were made at the Bessie mine, in Athens county, and at mine No. 15 and Snake Hollow, in Hocking county. There are 31 mines in the State equipped with machines, in which 82 machines are operated by electricity and a like number by compressed air; 28,998 persons found employment in and about the mines during the year. Of this number, 22,416 were miners and 6,582 were day hands, as against 25,163 miners and 6,330 day hands during the year of 1894. In reviewing the summaries of the preceding tables, it is found that after deducting from the whole number of miners employed those who were engaged in operating mining machines there were 18,645 miners employed as pick miners, a decrease of 3,863 as compared with 1894.

It is also found by deducting from the total output of the State the amount of machine mined coal that 10,563,423 tons were produced by pick mining, an increase as compared with the previous year of 1,208,670 tons. This makes an average yearly production of $566\frac{1100}{2000}$ tons of run of mine coal to the individual, a gain of $131\frac{1220}{2000}$ tons as compared with 1894 and a loss of 63 tons when compared with 1893. The year opened with the scale rate of mining at 60 cents per ton, which continued until May 1, when a general suspension occurred. On June 1 the mines resumed on a 51-cent basis, which continued until October 1, when the scale rate advanced to 55 cents, where it remained during the balance of the year. The report shows that each miner averaged 168 days' work, from which it will be seen that each miner made a daily average production of $3\frac{740}{2000}$ tons, against $2\frac{1160}{2000}$ tons in 1894, and compared with $3\frac{1800}{2000}$ tons during the year 1893.

Acetylene for Photometric Purposes.

The London *Journal* notes that at a recent meeting of the French Physical Society, M. Violle recommended the use of acetylene for photometric purposes. The gas, after being compressed in a bomb, leaves it under a pressure equivalent to a 30-centimeter water column, and passes through a small conical mouthpiece where it absorbs enough air for combustion, which takes place in a burner of the Manchester type. The flame is protected against the surrounding air by a double metallic casing. By using only a part of the flame, photometrical values ranging from 5 to 20 candle-power are obtained. The total flame represents 100 candles, and can be increased to 125 candles by increase of pressure. Two diaphragms, one on each side of the burner, are provided with scales which indicate the lighting power of the flames measured. The color of the flame can be changed, and consequently its power of incandescence. If the pressure is increased, the flame adopts a rose-red tinge which is noticed in the combustion of carbureted substances if occurring at high temperatures.

The Market for Gas Securities.

On a small volume of business, Consolidated declined to 143¼ in the week, the opening today (Friday) being reported at 144 to 144¼. Realizing sales, and lack of purchasing orders, were undoubtedly the causes that led to the lower range of values, for nothing respecting the Company or its standing has transpired to cause the decline. Other city shares are firm at the figures quoted a week ago, although some weakness was developed in East River common.

Brooklyn Union gas is steady, at 86 to 87, and some inquiry exists for the bonds, which are 104 bid.

Chicago gas shows no particular change as the result of the week's trading, although at one time values therein were marked down with surprising rapidity. The fact should not be lost sight of that next month will witness the beginning of the end of the legal troubles which have beset the Company. Lacledes are better than at last reporting, and Bay States are still in disfavor. San Francisco gas is in better demand with 89½ freely bid for it. A feature of the recent market is the persistent inquiry for gas bonds of almost every grade, and some of the issues on Western properties look particularly inviting.

Gas Stocks.

Quotations by Cochran & Close, Brokers and Dealers in Gas Stocks.

35 Wall St., New York City.

Sept. 21.

☞ All communications will receive particular attention.

☞ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$35,480,000	100	144	144¼
Central	500,000	50	150	..
" Scrip	220,000	..	100	.
Equitable	4,000,000	100	204	208
Bonds, 6's	1,000,000	1,000	105	.
" 1st Con. 5's	2,300,000	1,000	114	.
Metropolitan Bonds	658,000	..	108	112
Mutual	3,500,000	100	210	..
" Bonds	1,500,000	1,000	100	102
Municipal Bonds	750,000	.	..	
Northern	150,000	50	79	80½
" Bonds	150,000	1,000	..	98
New York and East River	5,000,000	100	33	35
Preferred	2,000,000	100	..	65
Bonds 1st 5's	3,500,000	1,000	96	98
" 1st Con. 5's	1,500,000	.	83	88
Richmond Co., S. I.	348,650	50	50	..
" Bonds	100,000	1,000		
Standard	5,000,000	100	74	77
Preferred	5,000,000	100	99	102
Bonds, 1st Mortgage, 5's	1,500,000	1,000	107	111
Yonkers	200,650	50	130	
Out-of-Town Companies.				
Brooklyn Union	15,000,000	100	86	87
" " Bonds (5's)	15,000,000	1,000	104	105
Bay State	5,000,000	50	15	16⅛
" Income Bonds	2,000,000	1,000	30	32
Boston United Gas Co.—				
1st Series S. F. Trust	7,000,000	1,000	73	..
2d " " "	3,000,000	1,000	60	62
Buffalo Mutual	750,000	100	125	..
" Bonds	200,000	1,000	95	100
Central, San Francisco	2,000,000	..	95	..
Chicago Gas Co.	25,000,000	100	59¼	59½
Chicago Gas Lt. & Coke Co. Guaranteed Gold Bonds.	7,650,000	1,000	94	94¼
Columbus	1,069,000	..	..	65
1st Mortgage	1,085,000	..	..	96
Consumers, Jersey City	2,000,000	100	60	75
" Bonds	600,000	1,000	97	101
Cincinnati G. & C. Co.	7,000,000	100	155	..
Consumers, Toronto	1,600,000	50	184½	187
Capital, Sacramento	500,000	50	..	41
Bonds (6's)	150,000	1,000	..	..
Consolidated, Baltimore	1,000,000	100	59½	61
Mortgage, 6's	3,600,000	..	107	107½
Chesapeake, 1st 6's	1,000,000	..	..	..
Equitable, 1st 6's	910,000	..	..	..
Consolidated, 1st 5's	1,490,000	..	..	..
Detroit	4,000,000	..	32	33
" Con. Bonds	4,312,000	..	..	85
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Fort Wayne	2,000,000	..	78	83
" Bonds	2,000,000	..	85	90
Hartford	750,000	25	..	14
Indianapolis	2,000,000	..	115	130
" Bonds, 6's	2,650,000	..	99½	101½
Jersey City	750,000	20	180	..
Lafayette Gas Co., Ind	1,000,000	100	..	90
Bonds	1,000,000	1,000	85	90
Louisville	2,570,000	50	..	..
Laclede, St. Louis	7,500,000	100	22½	23
Preferred	2,500,000	100	.	80
Bonds	9,034,400	1,000	89	89½
Little Falls, N. Y.	50,000	100	..	100
Bonds	25,000	..	..	100
Montreal, Canada	2,000,000	100	200	.
Newark, N. J., Gas Co.	1,000,000	..	93	98
Bonds, 6's	4,000,000	..	123	..
New Haven	1,000,000	25	225	..
Oakland, Cal.	2,000,000	..	52	53¼
" Bonds	750,000	..	..	..
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	2,100,000	1,000	..	108
2d "	2,500,000	1,000	104	105
Peoples, Jersey City	500,000	50	..	175
Paterson, N. J.	.....	25	99	102
Rochester Gas & Elec. Co.	2,150,000	50	..	..
Preferred	2,150,000	50	83	..
Consolidated 5's	2,000,000		87½	90
San Francisco, Cal.	10,000,000	100	86½	87
St. Paul Gas Light Co.	1,500,000	100	67½	70
1st Mortgage, 6's	650,000	..	84	87
Extension, 6's	600,000	..		..
General Mortgage, 5's	2,400,000	.	88	90
Syracuse, N. Y.	500,000	25	..	..
Washington, D. C.	2,000,000	20	250	
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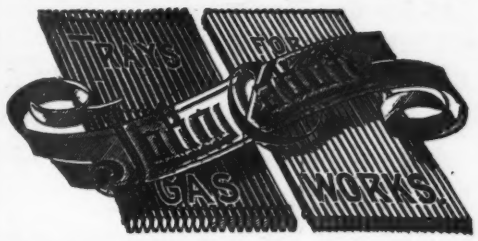

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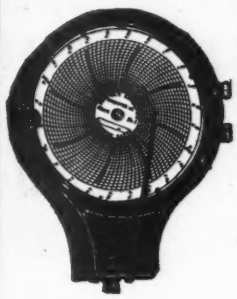

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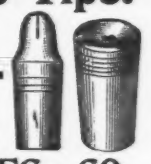

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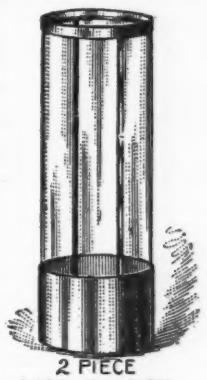

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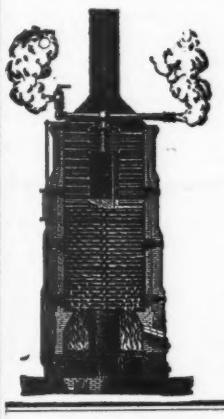

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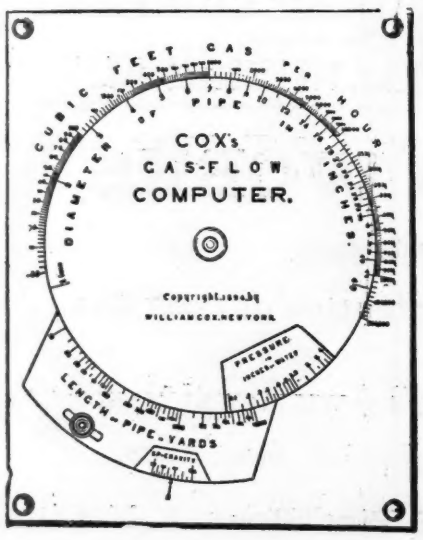

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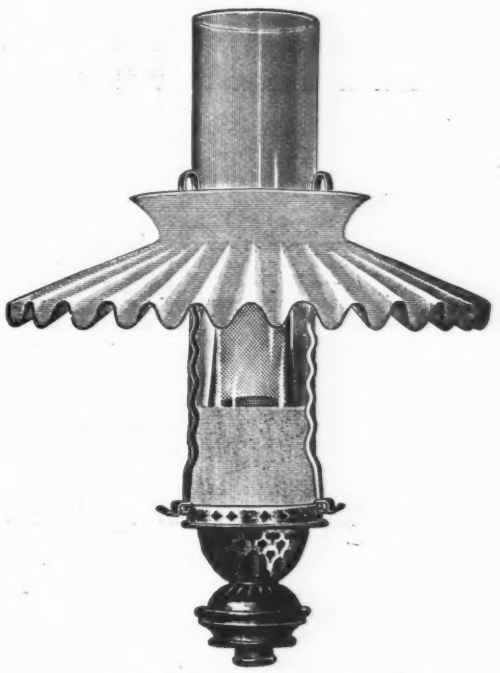

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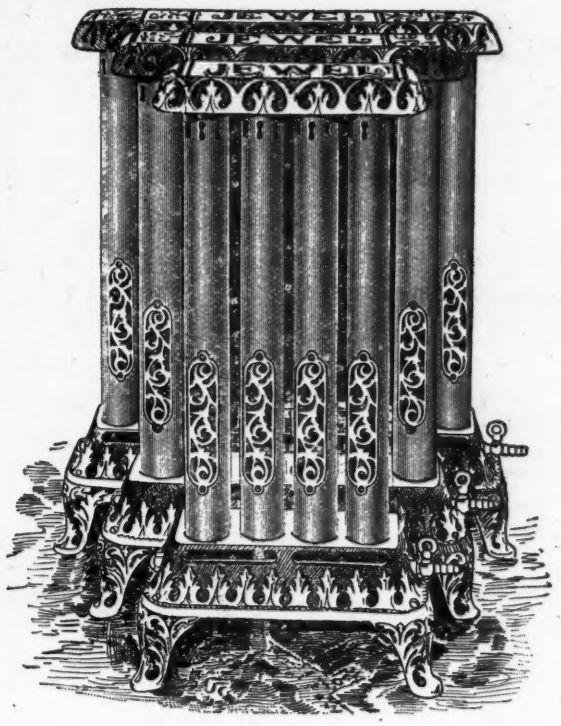

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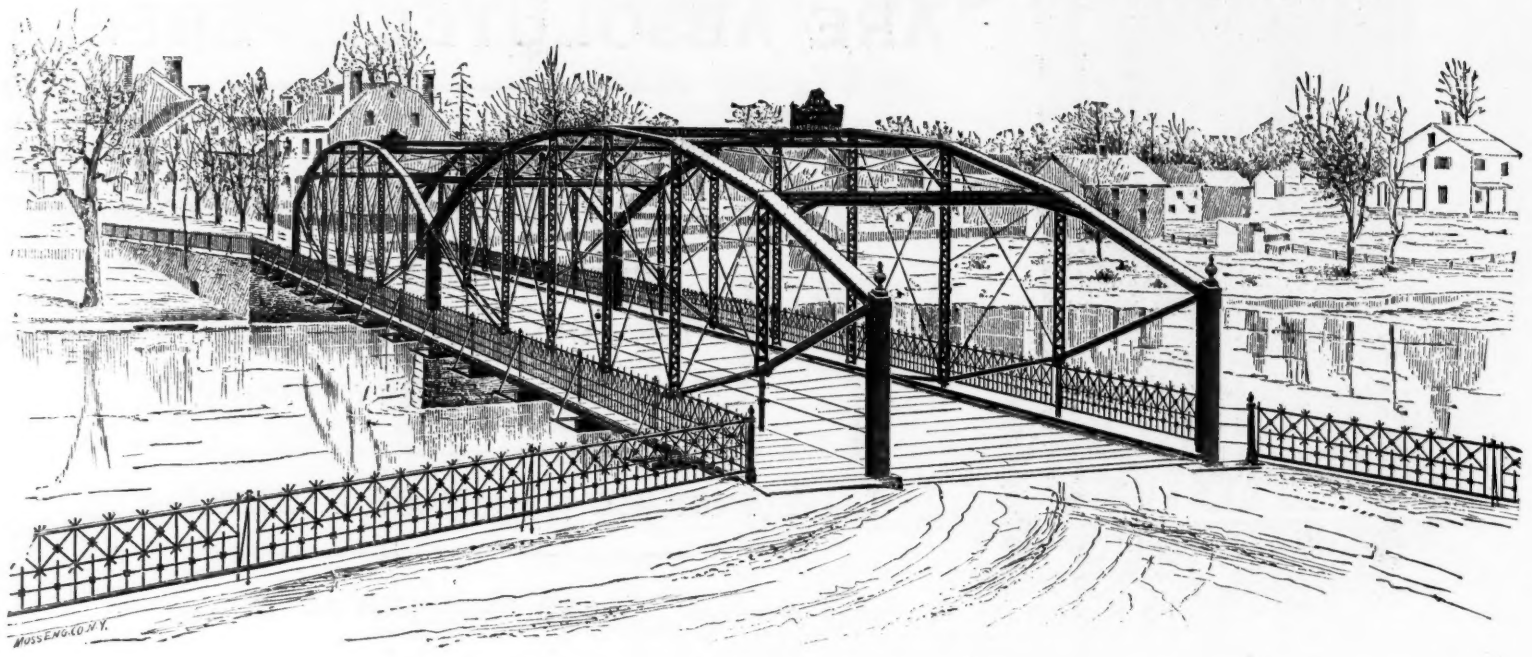

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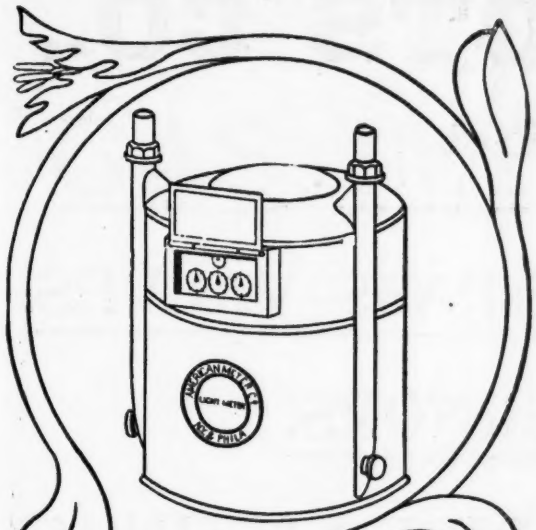

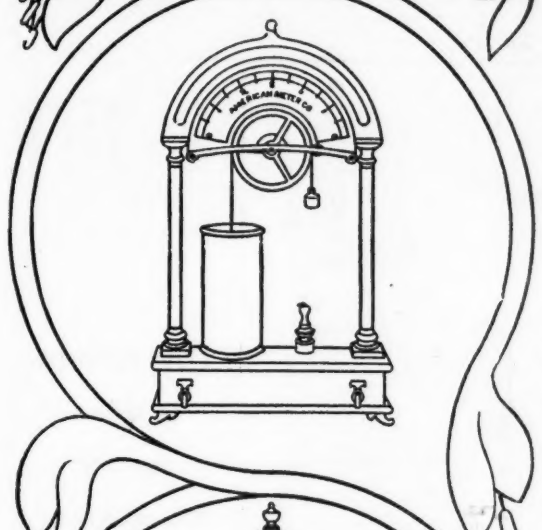

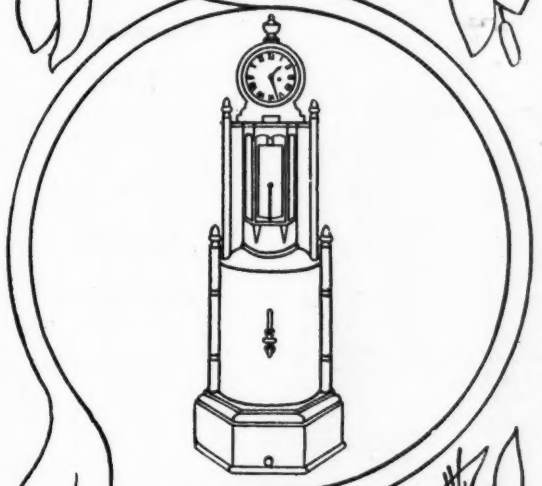

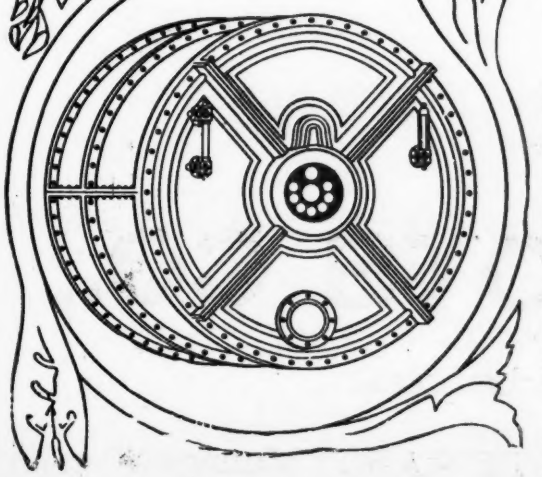

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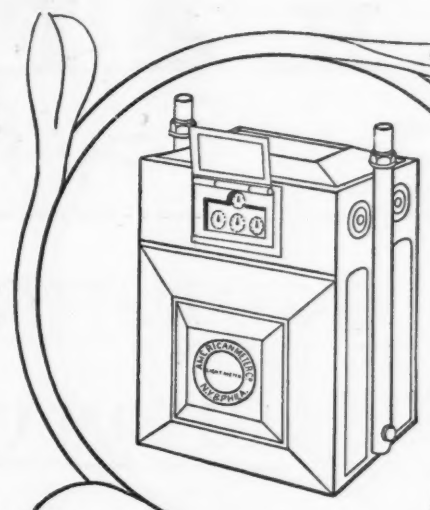
PUBLIC LIGHTING TABLE.

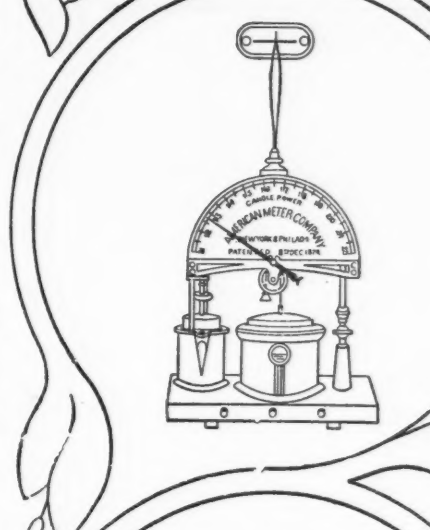
OCTOBER, 1896.

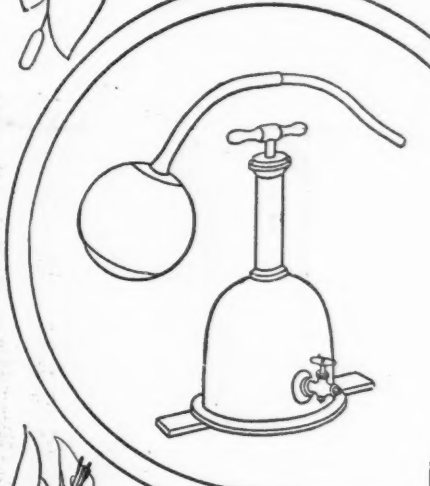
Day of Week.	Date.	Table No. 1. Following the Moon. Light.	Table No. 1. Extinguish.	Table No. 2. New York City. All Night Lighting. Light.	Table No. 2. Extinguish.
				P.M.	A.M.
Thu.	1	6.10 PM	1.30 AM	5.30	5.00
Fri.	2	6.10	2.50	5.30	5.00
Sat.	3	6 10	5.00	5.30	5.00
Sun.	4	6.00	5.00	5.30	5.00
Mon.	5	6.00	5.00	5.30	5.00
Tue.	6	6.00 NM	5.00	5.30	5.00
Wed.	7	6 00	5.00	5.30	5.00
Thu.	8	6.00	5.00	5.20	5.10
Fri	9	6.00	5.00	5.20	5.10
Sat.	10	6.00	5.00	5.20	5.10
Sun.	11	7.50	5.10	5.20	5.10
Mon.	12	9.00	5.10	5.20	5.10
Tue.	13	10.10 FQ	5.10	5.20	5.10
Wed.	14	11.10	5.10	5.20	5.10
Thu.	15	12.20 AM	5.10	5.10	5.20
Fri.	16	1.20	5.10	5.10	5.20
Sat.	17	2.20	5.10	5.10	5.20
Sun.	18	3.20	5.20	5.10	5.20
Mon.	19	4.20	5.20	5.10	5.20
Tue.	20	No L.	No L.	5.10	5.20
Wed.	21	No L. FM	No L.	5.10	5.20
Thu.	22	No L.	No L.	5.00	5.30
Fri	23	5.40 PM	6.50 PM	5.00	5.30
Sat.	24	5.40	7.30	5.00	5.30
Sun.	25	5.30	8.10	5.00	5.30
Mon.	26	5.30	9.10	5.00	5.30
Tue.	27	5.30	10.10	5.00	5.30
Wed.	28	5.30	11.20	5.00	5.30
Thu.	29	5.30 LQ	12.30 AM	4.45	5.35
Fri.	30	5.30	1.40	4.45	5.35
Sat.	31	5.30	2.50	4.45	5 35

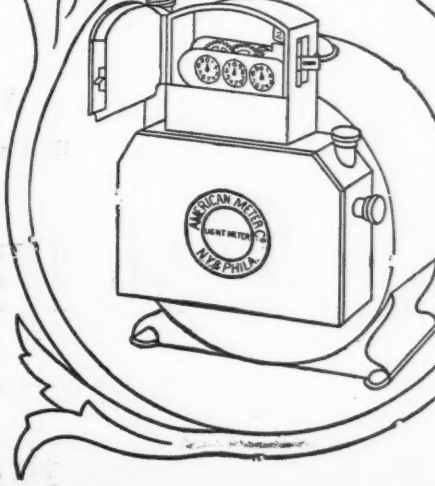
TOTAL HOURS LIGHTING DURING 1896.

By Table No. 1.	Hrs.Min.	By Table No. 2.	Hrs.Min.
January	220.40	January	423.20
February	207.00	February	367 40
March	193.00	March	355.35
April	174.10	April	298.50
May	164.00	May	264.50
June	142.10	June	234.25
July	142 10	July	243.45
August	150.50	August	280.25
September	163.00	September	321.15
October	193.10	October	374.30
November	207.00	November	401.40
December	237.30	December	433.45
Total, yr.	2194.40	Total, yr.	4000.00









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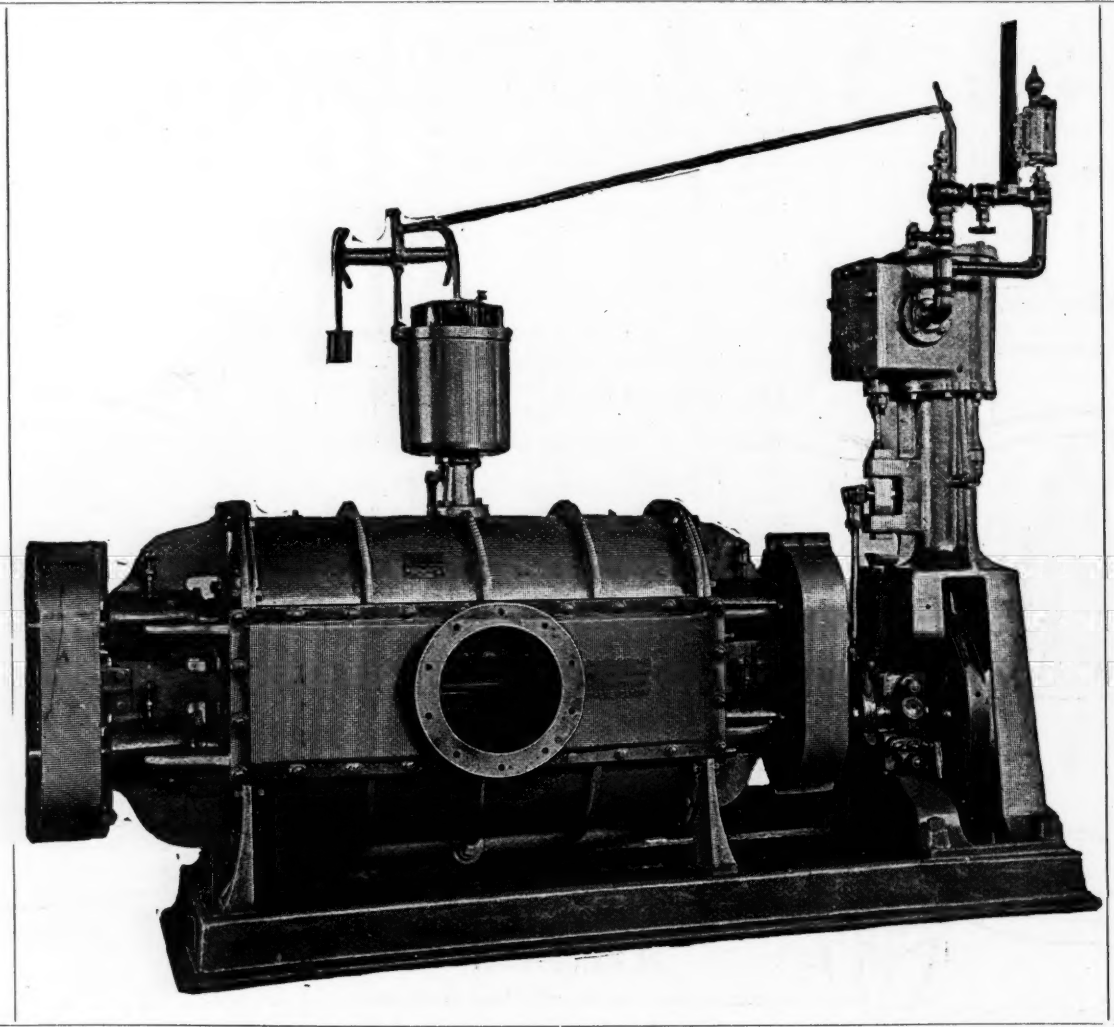

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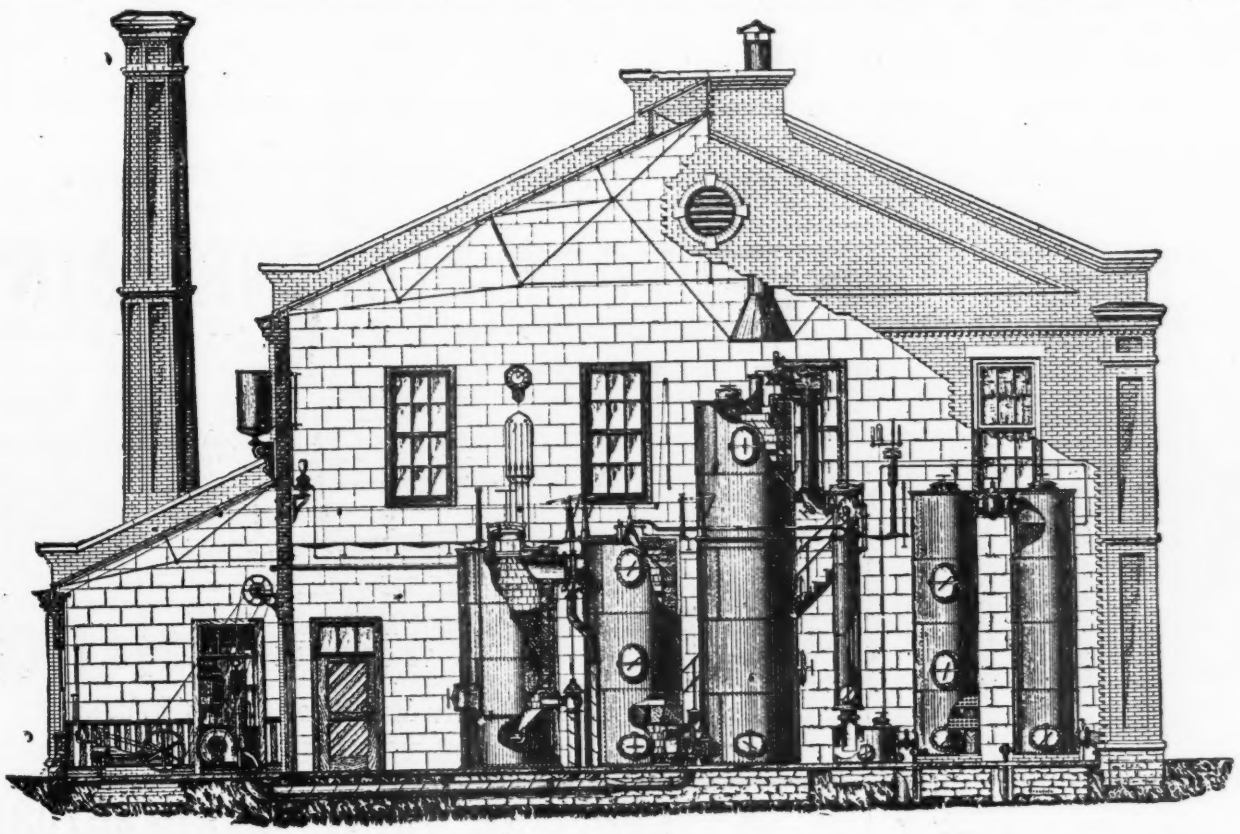

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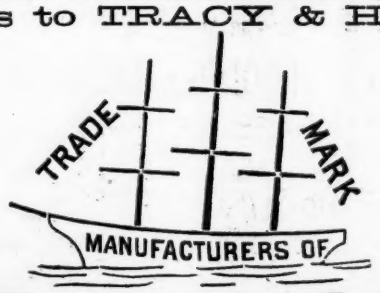

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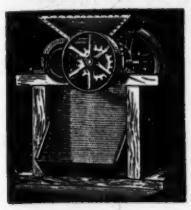

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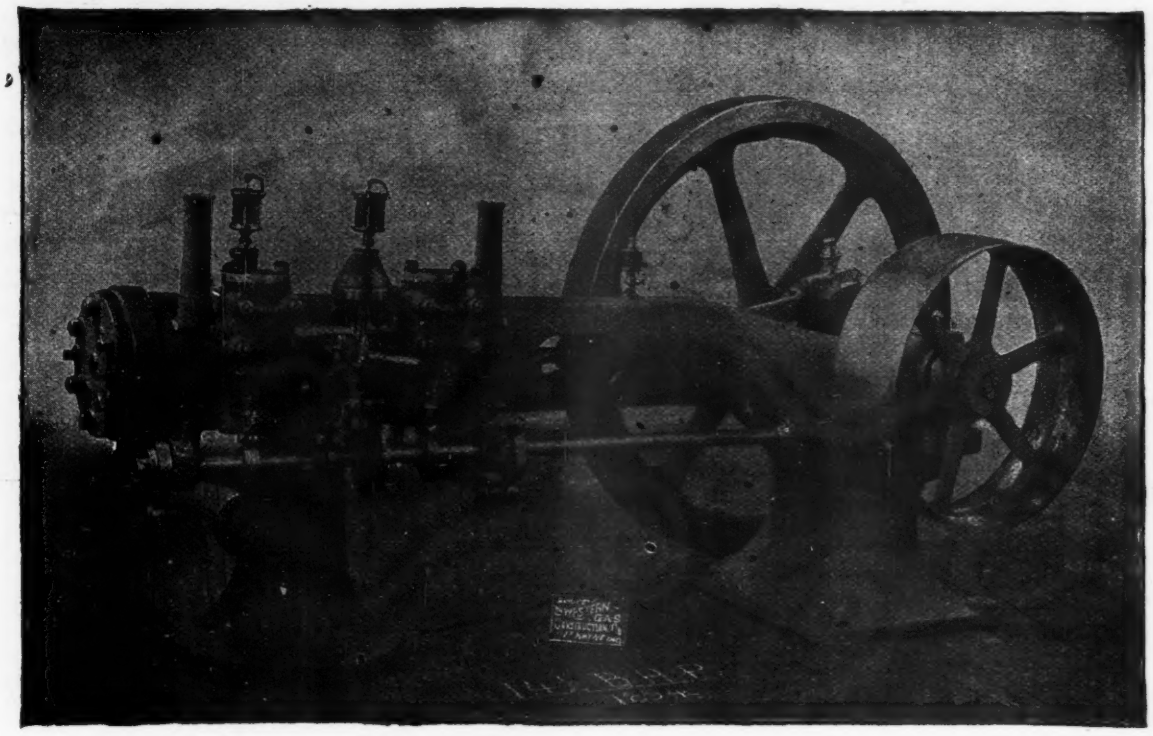

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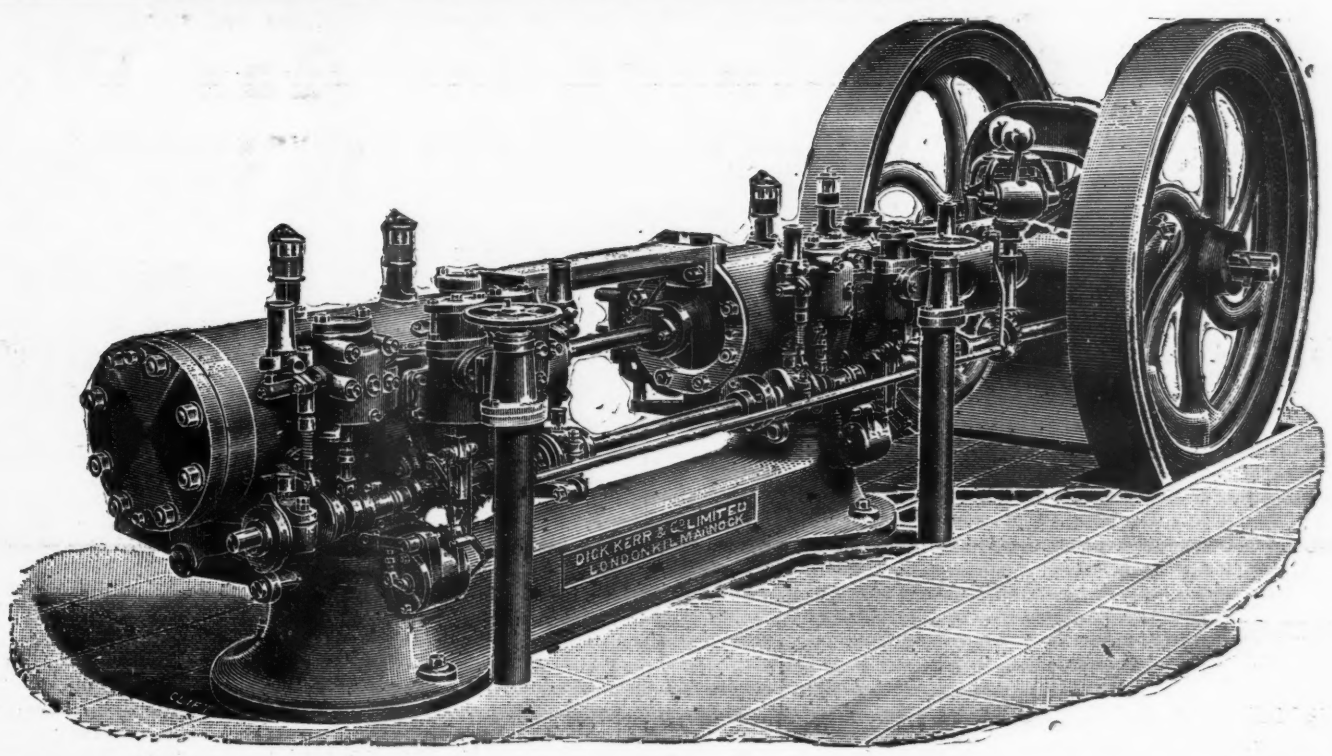

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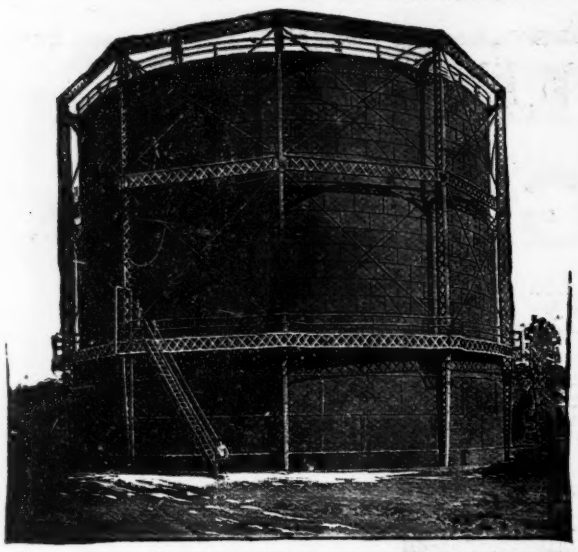

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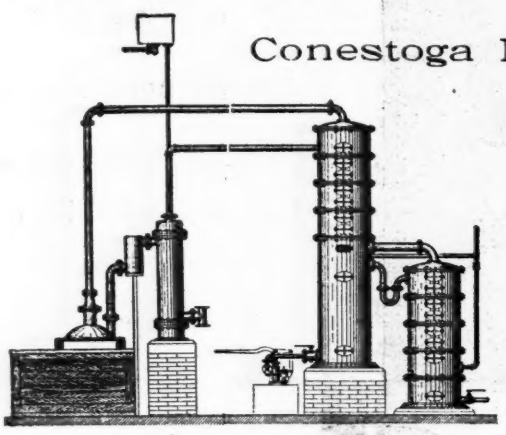

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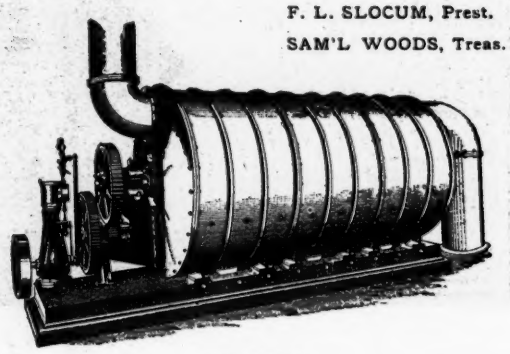

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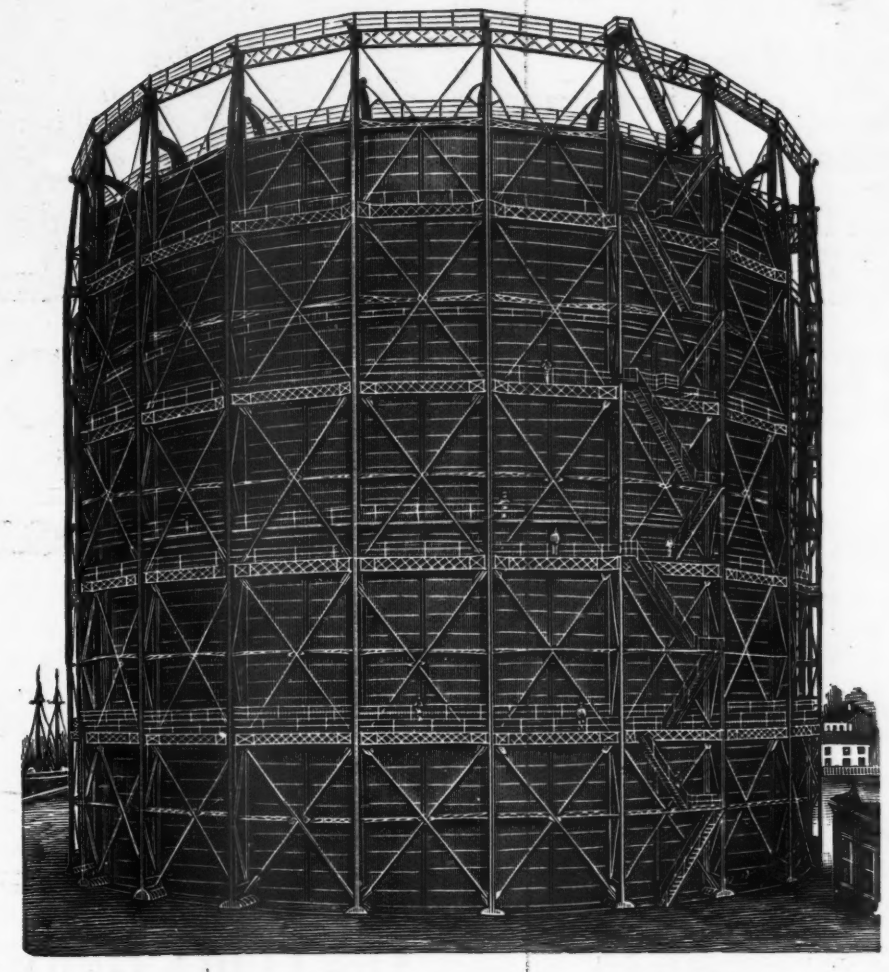

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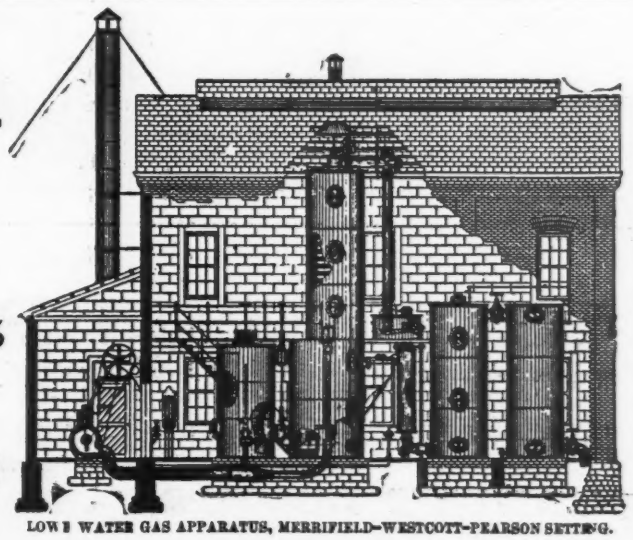

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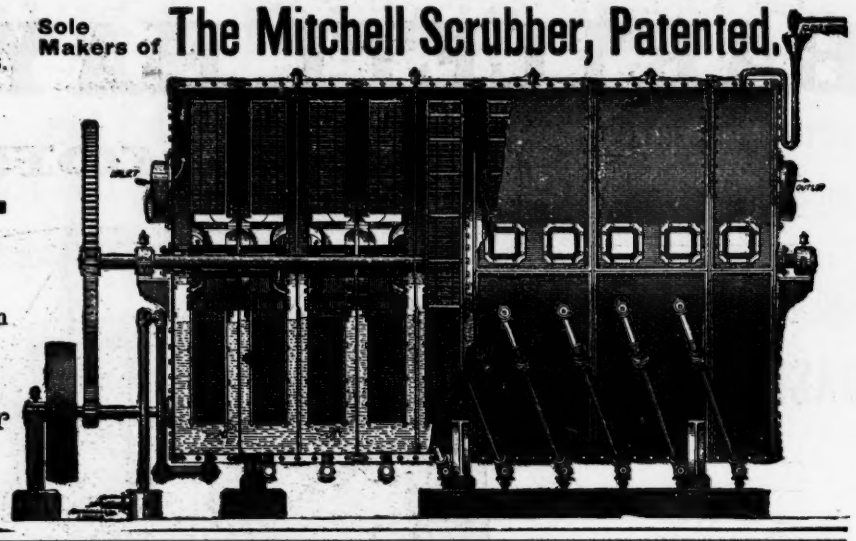

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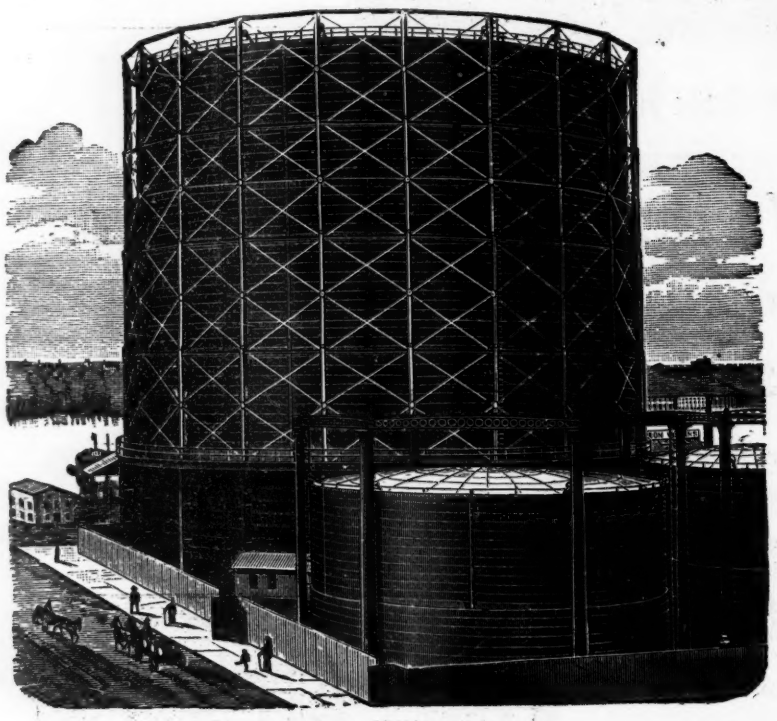

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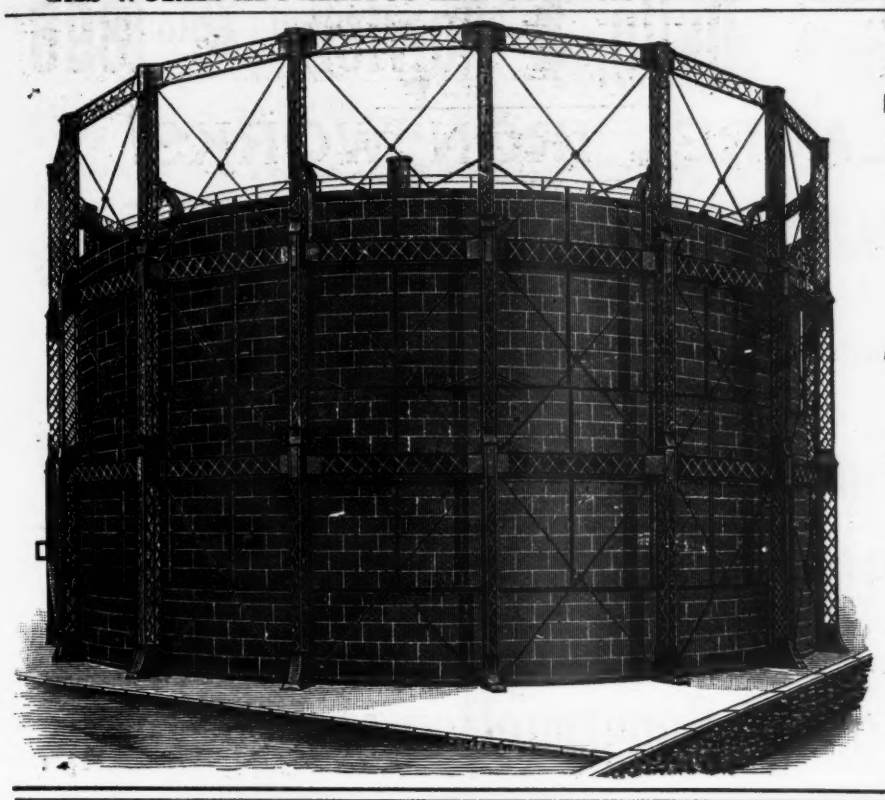

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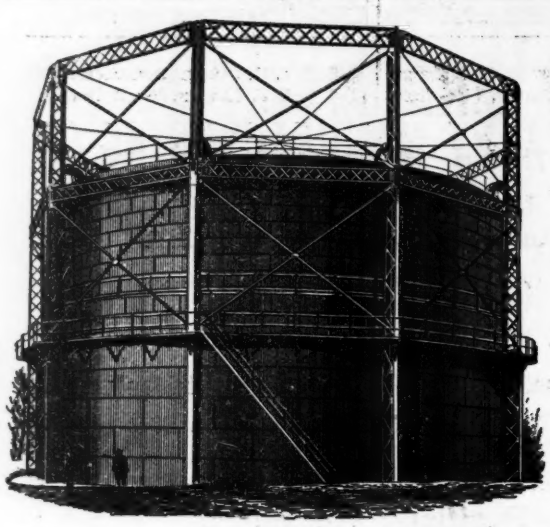

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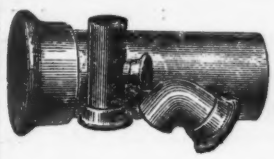

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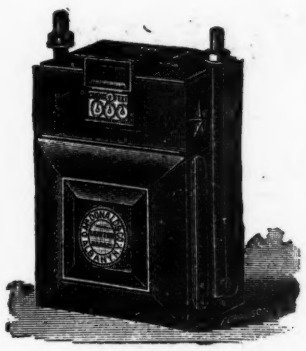

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